INSTRUMENTS—INDICATING, RECORDING, CONTROLLING

BRISTOL'S

THE BRISTOL CO. WATERBURY 20, CONN

I M P O R T A N T

1. Read these instructions NOW before installing instrument.

2. Keep these instructions permanently & accessibly filed for future reference.

3. Be sure to specify MODEL & SERIAL numbers when ordering parts, instructions, diagrams or data.

4. Ship instruments or parts for repair or exchange only to Bristol's main or branch factories—not to Sales Offices.

5. Be sure to—
   1. Identify your shipments with your exact return address & order number.
   2. Write nearest Bristol Factory or office giving your order number, directions & address for return shipment, full instructions for repair, etc.

6. Report damage to shipments at once to shipping company. The *customer assumes responsibility for collecting any claim for damages* from the shipping company, on all shipments made on a collect basis.

WHO WILL SERVICE YOUR BRISTOL INSTRUMENT?

Divided responsibility produces misunderstanding and inattention. We therefore urge that all Bristol instruments in your plant be assigned to the care of one responsible man. He will rapidly become so familiar with routine chart changing, inking, checking and adjusting necessary to keep instruments in good working order, as to require only a few minutes time per day. Bristol will be pleased to supply additional information or personal instruction to instrument service men.

INSTRUCTION B2100

(Replaces 2550 and 3516)

BRISTOL'S INDICATING THERMOMETER ELECTRIC CONTROLLER

Models 177-B, 277-B, 377-B, 180-B, 280-B, 380-B, 187, 287, 387

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THE BRISTOL COMPANY WATERBURY 20, CONNECTICUT

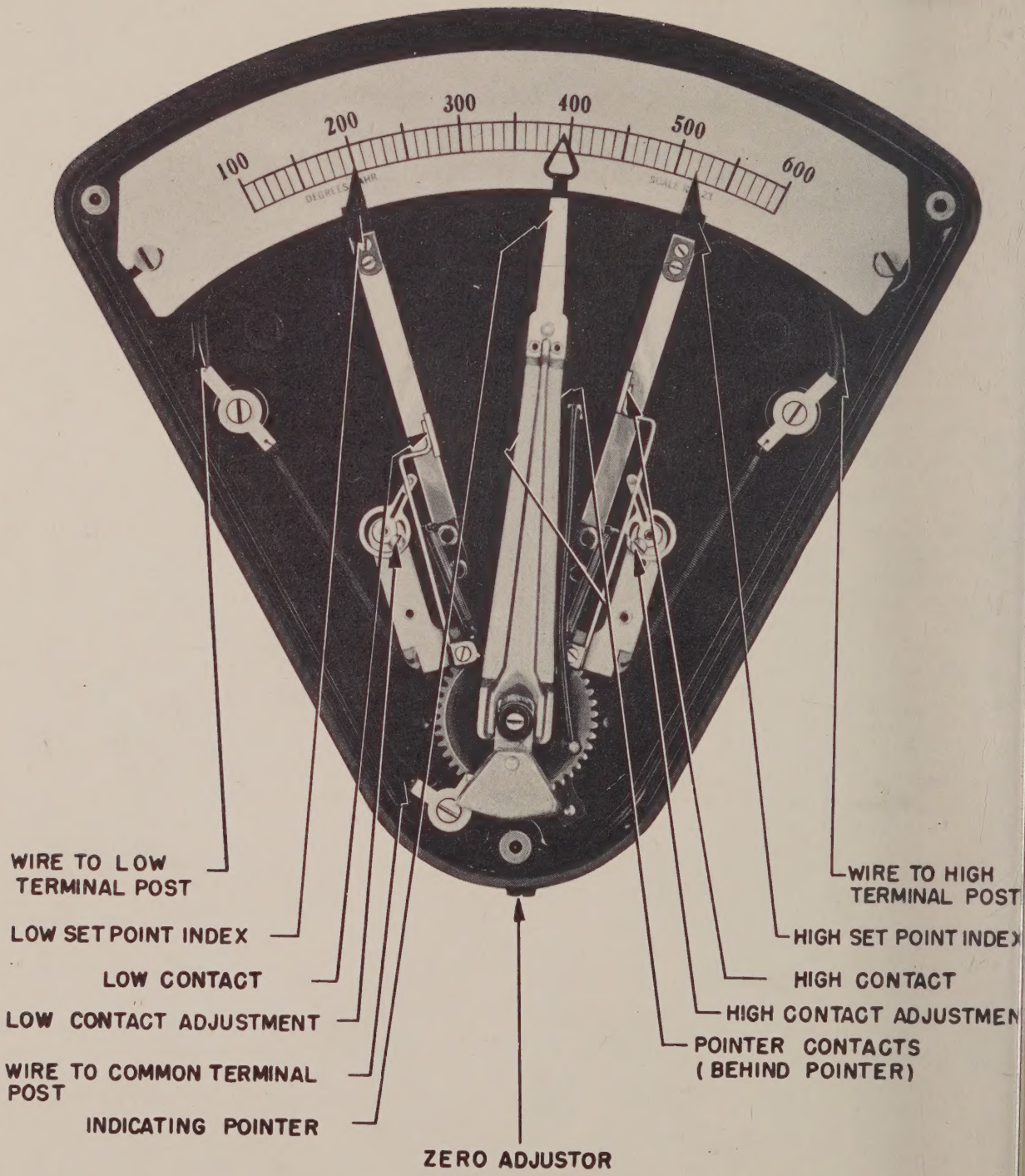


FIGURE I- ELECTRIC CONTACT TEMPERATURE CONTROLLER

PART I GENERAL

Note: This instruction covers the installation, operation and service of Bristol's Indicating Thermometer Electric Controller. See separate instructions attached covering the installation of the thermometer system.

. Description

Bristol's Thermometer Electric Controller consists of a sealed pressure-type thermometer system including a pressure-sensitive measuring element and the associated indicating and controlling mechanism. The instrument is designed to operate "on-off" controls within any specified temperature range between -60°F and 1000°F.

. Principle of Control (refer to photograph on page 2)

The controller has three binding posts marked H, C and L, meaning high, common and low. These posts are internally connected at the factory as follows: H to the right-hand contact, C to the pointer contact and L to the left-hand contact. In some models only the high or low contact is connected.

The position of the low contact is indicated on the scale by the green set-point index arm (contact arm) and is adjusted by the left knob on the front of the case. The position of the high contact is indicated on the scale by the red set-point index arm (contact arm) and is adjusted by the right-hand knob. In some models both high and low contact arms are fastened together by a small removable link, and both arms are set by only one knob. They are not adjustable separately. In models with 2 knobs the high and low contact arms are separately adjustable.

As the temperature changes, the internal pressure of the sealed thermometer system changes, and the pressure-sensitive measuring element moves the indicating pointer up or downscale. When a rising temperature moves the pointer high enough, the pointer contact touches the contact on the high set-point index arm completing a circuit between H and C. When a falling temperature moves the pointer downscale far enough, the pointer contact touches the contact on the low set-point index arm completing a circuit between L and C. By connecting the L, C and H terminals to various loads such as motor valves, relays, etc., the temperature of a process can be controlled at or between any desired temperatures.

PART II INSTALLATION

. Location of the Instrument

Locate the instrument on a firm support. It should be as free as possible from dirt, dust, vibration and corrosive fumes. See the attached manual for handling and installing the thermometer bulb and tubing.

. Setting the Contacts

The contacts referred to here are those that are attached to the low and high set-point index arms (often called contact arms). If these two arms are fastened together so that they cannot move separately, they will always be the same distance apart but may be moved up and downscale together by the single knob located on the front of the case. For changing the distance between these contacts see paragraph C below.

If the two arms are not fastened together, there will be two adjusting knobs or screws on the front of the case for moving the arms separately. If control is desired with these arms set as close together as possible, it may be necessary to change the minimum distance between them. See paragraph C below for this adjustment.

Older models of the thermometer electric controller may have some contact arm setting devices other than the knobs on the front of the case. These may be two small knurled thumbscrews at the rear of the case or a small projecting lever and screw arrangement on the bottom of the case.

C. Adjusting Minimum Dead Space (see photograph on page 2).

When the high and low index arms are set as close together as possible, there must be some clearance between the high and

(over)

C. Adjusting Min. Dead Space -cont'd from pg. 3

low control contacts and the indicating pointer contact. If both high and low contacts touched the pointer contact simultaneously, both H and L circuits would be connected at once and the relay and contacts would be damaged. The clearance required to prevent this is called minimum dead space.

The contacts are adjusted at the factory to a minimum of 1/32th of an inch. This gives a dead space of 0.7% of full range. Thus, if a controller had a range of 0° to 200°F, the minimum dead space would be .7% x 200 = 1.4°F.

Either high or low contacts may be adjusted to change this space. On the singly-adjustable 2-contact controllers (where the index arms are fastened together) this is the only method of adjusting dead space. On the separately-adjustable 2-contact controllers the index arms can be adjusted individually.

To adjust loosen the setscrew on the high or low contact adjustment tab. (For location of parts see photograph on page 2). Turn the tab in the direction desired. Minimum clearance can be tested by holding the high and low contact arms together and moving the indicating pointer between them. Tighten the setscrews. On older models the minimum space was not adjustable. These models should be returned to the factory for adjustment.

D. Wiring of Control Circuits (see figures 5, 6 and 7)

The attached wiring diagrams show several possibilities for the wiring of control loads. It is recommended that lock-in-type relays always be used when operating non-inductive loads requiring more than 50 watts ($\frac{1}{2}$ ampere at 115 volts or $\frac{1}{4}$ ampere at 230 volts). All inductive loads should be operated thru relays.

The nature of the contacts in the thermometer controller is such that lock-in-type relays will produce the best results in control and the longest life of the instrument.

1. Your instrument may have a singl set-point index for L or H control

a. In the L (low)type of control th load is turned on when the temperatur goes **below** the set-point index and of when the temperature goes above the set point index (see Fig.2 in the attache diagram).

b. In the H (high) type of contro the load is turned on when the tempera ture goes **above** the set-point index an off when the temperature goes below th set-point index (see Fig. 3).

2. If your instrument has two set-point indexes, it can furnish LH o LOH control.

a. In the LH (low-high) type of con trol, using a lock-in-type relay, the lo load is turned on when the pointer is be low the low set-point index and stays o until the pointer goes above the hig set-point index where it is turned off Then the high load is turned on when th pointer goes above the high set point an stays on until the pointer goes below th low set point where the low load is turne on again.

b. The LOH (low-off-high) type o control does **NOT** use the lock-in-typ relay. The low load is turned on whe the pointer is below the low set point no loads are on when the pointer i between the low and high set points, an the high load is turned on when th pointer is above the high set point

E. Use of the Controller as an Indi cator Only.

In some cases the control loads ma be disconnected and the instrument use as an indicator. This may be done **on** when there are two control points (i.e. two set-point indexes with two knobs the front of the case). The set-poi index arms should be turned to the e treme ends of the scale so that t pointer is free to move over the enti scale. In any other type of instrume certain internal modifications are ne essary. This should be done by t factory.

PART III OPERATION

Bristol's Indicating Thermometer Electric Controller begins to operate as soon as the thermometer bulb is placed in the measuring location and the co trol loads are connected to the instr ment.

PART IV SERVICE

A. Position for Checking Instrument Readings

In order to give exact readings, the indicating pointer contact must not be touching either of the contacts on the set-point index arms. The reason for this is that the contacts, when touching, offer a mechanical resistance to the movement of the pointer. Thus, when the pointer is above the high set-point index, it will read low and when it is below the low set-point index, it will read high. Because the instrument was designed as a controller, it is not necessary that the indicating pointer be exact except between the control points. See paragraph E in Section II for using the instrument as an indicator.

B. Comparison with a Standard Thermometer

To check the accuracy of the instrument between the control points, compare the indicated temperature with that of a high-quality test thermometer of known accuracy. Make sure that the test thermometer covers the range to be checked.

Remove controller bulb from its measuring location and immerse into the test bath with the test thermometer. A water bath can be used to 210°F (99°C) and an oil bath used for higher ranges. The sensitive portion of both bulbs must be completely covered. Agitate the bath constantly and vigorously. Allow at least 3 minutes before comparing readings.

C. Calibration

1. Model 77B and 80B (triangular-shaped case). If the instrument does not agree with the test thermometer, move the zero adjusting plate (located outside at the bottom of the case) to the left or right until the instrument agrees with the test thermometer. This adjusting plate is locked in position by a screw. Retighten screw firmly after making any adjustment.

2. Model 87 (rectangular-shaped case). Remove cover. Loosen screw located in curved slot in lower right corner and slip it up or down until pointer agrees with test thermometer. Retighten screw firmly.

After making any calibration adjustment, be sure to reset the set-point indexes to their normal operating points.

D. General Service and Trouble Analysis

1. Keep the instrument clean and dry.

2. If the thermometer system continuously reads low or zero and cannot be corrected by the calibration procedure described in paragraph C above, it is probable that the system is leaking. It is necessary to return such thermometers to the Bristol factory for refilling and calibration. It is generally advisable to send the controller complete.

3. If the control loads do not operate properly, check the electrical contacts in the instrument. They are subject to normal wear and should be replaced when pitted or corroded. Check relays and control loads as well.

4. Ship all parts or instruments for repair or exchange only to Bristol's Branch or Main factories, never to Branch offices. Address all correspondence and orders to the nearest Bristol Branch office a list of which will be found on the last page of all instruction books. Be sure to state model and serial number of instrument in all orders and correspondence.

The Bristol Company
Waterbury 20, Conn.

LOW CONTROL

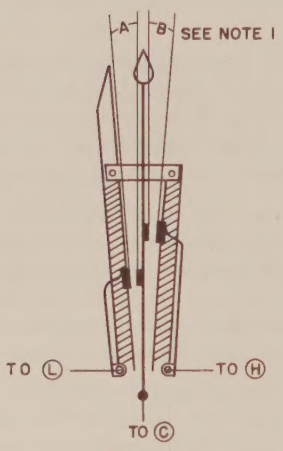


FIGURE 2

HIGH CONTROL

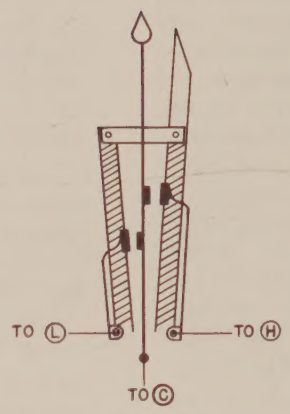


FIGURE 3

LOW-HIGH CONTROL

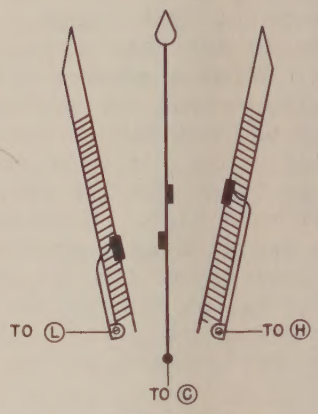


FIGURE 4

NOTE 1-A+B SHOULD NOT BE LESS THAN 1/32".

SCHEMATIC DIAGRAM SHOWING CONTROLLER CONTACT POSITIONS FOR VARIOUS TYPES OF CONTROL

LOW CONTROL

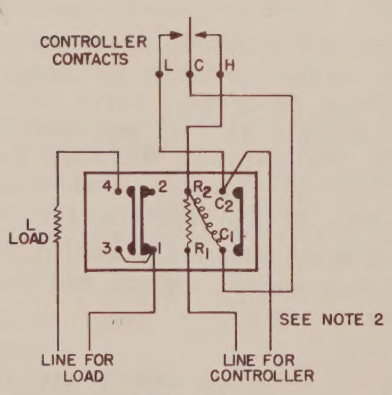


FIGURE 5

HIGH CONTROL

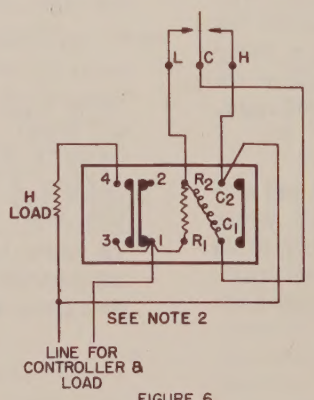


FIGURE 6

LOW-HIGH CONTROL

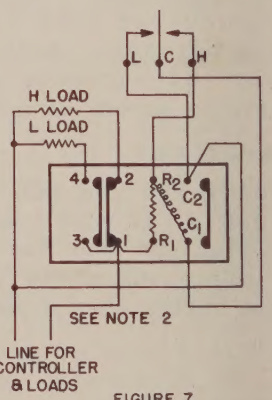


FIGURE 7

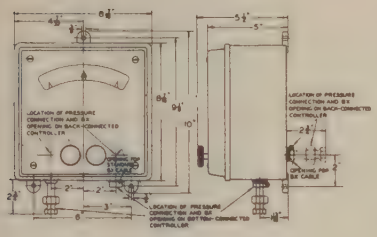
NOTE 2- COMMON OR SEPARATE POWER CONNECTIONS MAY BE USED FOR CONTROLLER AND LOADS

SCHEMATIC WIRING DIAGRAM SHOWING USE OF LOCK-IN TYPE RELAY

ELECTRIC-OPERATED CONTROLLERS

INDICATING ONLY - OPEN CONTACT TYPE

Unless otherwise specified, controllers listed below are furnished complete with mounting screws and complete instructions.
Standard scales are listed in the catalogs.
Contact capacity - 50 watts or 1/2 ampere at 115 volts. Maximum safe voltage, 250 volts.
Specify whether singly or separately adjusted contacts are desired.

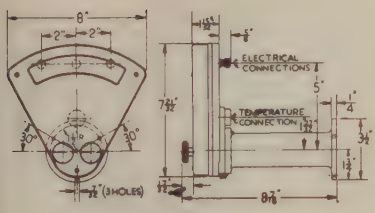


Model 87
For Pressure and Liquid Level
(Bottom or back connected)

PRESSURE - See limitations, Sales Date Sheet 265

Model	Description - Mounting	Range Limits	Price
77B	Triangular - Surface	0-30 psi to 0-500 psi	$ 72.00
80B	Triangular - Semi-flush..	0-30 psi to 0-500 psi	72.00
87	Square - Surface	0-12" water to 4.9 psi	102.00
87	Square - Surface	0-5 psi to 0-29.9 psi	97.00
87	Square - Surface	0-30 psi to 0-500 psi	87.00
87	Square - Surface	0-501 psi to 0-2000 psi ...	97.00
87	Square - Surface	0-2000 psi to 0-4000 psi ...	102.00
87	Square - Surface	0-4001 psi to 0-12,000 psi ..	112.00

Note: Models 77B and 80B Pressure Controllers are furnished with 12-inch flexible connection and 1/4-inch female union.
Note: If specified, the large diaphragm element type E may be substituted for ranges not under 241" head of water where the box type element is now standard. Additional price ..... $ 4.00



Model 77B
For Pressure, Liquid Level
and Temperature

LIQUID LEVEL - See limitations, Sales Data Sheet 265

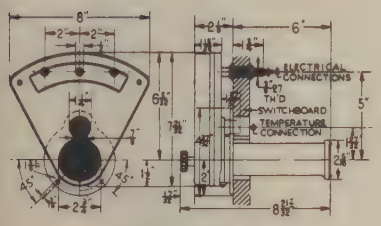
BULB TYPE

Model	Description - Mounting	Range Limits	Price
77B	Triangular - Surface	0-70 feet water and above ..	$ 93.00
80B	Triangular - Semi-flush .	0-70 feet water and above ..	93.00
87	Square - Surface	0-12 ins. to 0-11.4 ft water	123.00
87	Square - Surface	0-11.5 ft to 0-69 ft water ..	118.00
87	Square - Surface	0-70 feet water and above ..	108.00

With 5 feet bendable copper tubing and 6-inch Fixture 108. Add for other tubing and other bulb fixtures per Price List L700.
Note: If specified, the large diaphragm element type E may be substituted for ranges not under 241" head of water where the box type element is now standard. Additional price ..... $ 4.00

FLOAT TYPE - Not furnished.

BUBBLER TYPE - Use price of suitable pressure controller above and add price of desired, bubbler fixture from Price List L720. (Mounted externally)



Model 80B
For Pressure. Liquid Level
and Temperature

TEMPERATURE - See data under Price List series T800 for price differentials applying to variations in specifications.

CLASS I, Bi-metallic element self-contained inside perforated base.

Model	Description - Mounting	Range Limits	Price
177B	Triangular - Surface	Temperature up to 200 deg F	$ 82.00

CLASS I, Liquid-filled, case-compensated*

Model	Description - Mounting	Range Limits	Price
177B	Triangular - Surface	Temp. up to 400 deg F	$ 82.00
180B	Triangular - Semi-flush	Temp. up to 400 deg F	82.00

CLASS I, Liquid-filled, fully compensated: Available in the square case. Model C187..... Write Sales Engineering Dept.

CLASS II, Vapor tension*

Model	Description - Mounting	Range Limits	Price
277B	Triangular - Surface	Temp. up to 550 deg F	$ 82.00
280B	Triangular - Semi-flush	Temp. up to 550 deg F	82.00

CLASS III Gas-filled, case compensated*

Model	Description - Mounting	Range Limits	Price
377B	Triangular - Surface	To 1000 deg F All Std.ranges	$78.00
380B	Triangular - Semi-flush	To 1000 deg F All Std.ranges	78.00

*Note: Price includes 5 feet bronze armored connecting tubing and plain copper bulb. Add for others per price lists under T800.

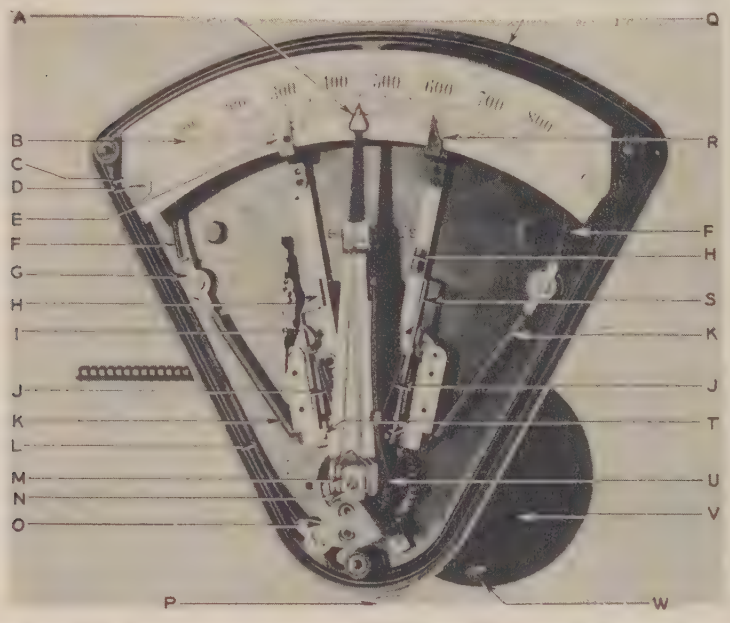
EXTRA FEATURE AND ACCESSORIES

racket for mounting on horizontal surface, Part 38893 (Photo 5176) ..... $ 5.50
xtra low and/or high contacts .....Write Sales Engineering Department giving details
onduit terminal covers for Model 77B ..... extra 3.30
crew driver control adjustment (instead of knobs) ..... no extra
pecial scales (see catalogs for standard scales) ..... extra 5.50
lexi-Glass window, part 89294 for Model 77B or 80B, in controller or furnished separately 1.00
llen Bradley Relays, enclosed. Single pole, double throw, one contact normally closed, one contact normally open, lock-in type.
ype BA 11, Part 70530, For 115 v., 60 cycles or 50 cycles ..... net to all $14.00
ype BA 11, Part 70342. For 230 v., 60 cycles or 50 cycles ..... net to all 17.00
ype BA 11, Part 70531. For 115 v., 25 cycles ..... net to all 16.00

Replaces Price List B210, page 2 of Sept. 30, 1950

PARTS FOR MODELS -77B & -80B CONTROLLERS

Do not use part numbers or prices for old Models 76, 77 or 80.



INTERIOR VIEW, MODEL 77B.

Give model and serial numbers of instruments when ordering parts.

Symbol	Description	Part Number	Price
A	Indicating pointer complete	48493	$ 5.00
B	Scale - calibrated as specified (cemented to scale plate)	.....	...
	Scale plate only (without scale)	29642	0.5
C	Washer for scale plate	35219	0.0
D	Screw for scale plate	61682	0.0
E	*Low adjustable contact pointer (for separately adjustable)	47783	3.0
F	Connecting lead to binding post (includes connectors)	48056	0.3
G	Screw for binding post lead connection	18339	0.0
H	Low and High adjustable contact surfaces - clean with fine file	35036	0.1
I	Low adjustable contact	30529	0.6
J	Contact spring (for high or low contact)	14466	0.0
K	Contact connecting spring -(for low or high contact)	39890	0.0
L	Pointer connection lead (includes connections)	48057	0.3
M	Screw for indicating pointer (included in A above)	18371	0.0
N	Washer for indicating pointer (included in A above)	18506	0.0
O	Pointer counterweight (included in A above)	34714	0.2
	Indicating pointer arm only (included in A above)	60490	2.0
P	Screw for zero adjustment	66539	0.0
Q	Case back (bakelite portion only) for 77B or 80B	47794	5.5
R	*High adjustable contact pointer (for separately adjustable)	47785	3.2
S	High adjustable contact	30535	0.6
T	Bearings for contacts - lubricate with clock oil	.....	...
U	Flexible pointer connection spring	30513	0.1
V	Base for Model 77B (flanged for surface mounting)	34117	2.7
	Base for Model 80B	35238	4.0
W	Mounting screw No. 10 - 7/8" long (wood screw)	698	0.0
	Mounting flange for Model 80B	66205	2.0
	Case cover complete - for separately adjustable contacts	47793	5.5
	- for singly adjustable contacts	48995	5.5
	- with no openings and for no adjustable contacts	48489	5.5
	Screw for cover - for separately adjustable contacts	47672	0.0
	- for singly adjustable contacts	60110	0.1
	Glass for cover	36790	0.1
	Clip for glass	11644	0.0
	Screw for glass clip	60407	0.0
	Control point adjustment knob - green, for low contact	49415	0.6
	Control point adjustment knob - red, for high contact (Singly adjusted instruments use this)	49416	0.5
	Binding post for Model 77B	32412	0.6
	Terminal for Model 80B	47676	2.0
	Terminal cover for Model 77B (7/8" opening for conduit)	60267	3.3
	Shaft including pinion gear for adjustment knob	48492	0.2
	*Strap for singly adjusted contact pointer	71773	0.1

*Note: Singly adjusted controllers use pointers 47783 and 47785 with strap 71773

THE BRISTOL COMPANY
Waterbury 20, Conn., U.S.A.

Reprint 1/50
Instruction T8000A
Issued 5/48

INSTRUCTION T8000A

UNPACKING INSTALLATION & SERVICE OF PRESSURE TYPE THERMOMETER TEMPERATURE MEASURING SYSTEM

Note: This instruction covers only the temperature measuring system. See front Index Page for instructions on installing case, operation of recording or controlling systems, etc.

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Note: This instruction applies to Class I, II & III case or fully compensated, single and multiple thermometer systems as used in indicating, recording and controlling thermometers, or as "temperature pens" in pressure gauges, flowmeters, etc.

If yours is an indicating instrument, please ignore reference herein to chart, pen, etc.

UNPACKING:

Warning: Handle thermometer tubing and bulb with care - do not twist, kink or strain tubing - do not bend it sharply. NEVER CUT TUBING OR DISCONNECT IT FROM BULB OR CASE COUPLING. Never use tubing to carry or support the instrument.

See instructions for Case and Recording System (front Index Page) for list of standard accessories supplied with each instrument.

PART I INSTALLATION

lote: In the following text, numbers in arentheses, such as (4), (15) etc., re- er to parts shown in figure 1.

. **GENERAL DESCRIPTION OF PRESSURE TYPE HERMOMETER SYSTEM.** The "thermometer ystem" consists of the helical pressure lement (24), connected by flexible capllary (fine bore) tubing (18) to a metal hamber or bulb (1). The bulb, tubing nd pressure element form a sealed "presure system" which is factory filled with fluid of kind depending on the class of hermometer, as follows:

Class I - Liquid filled systems.
Class II - Vapour actuated systems.
Class III - Gas filled systems.

his sealed pressure system must never be pened or broken for the filling fluid ill leak out, even thru the most minute rack or hole, making the system inoperaive.

s temperatures at the bulb (1) change, ressure changes or expansion of the fluid nclosed occurs. These are transmitted y capillary (18) to pressure element (24), ausing it to coil or uncoil, thus moving he pen or pointer thru link (14) and ever (10).

. **NAME PLATE DATA** - The name plate ounted inside door carries following nformation.

. **Model Number** - The model number is iven in full. The class of thermometer s given by the last number which follows he dash, as follows:

ast Number

1 - - - Class I liquid filled, case compensated
2 - - - Class II, vapor actuated
3 - - - Class III, gas filled, case compensated
11 - - - Class I, liquid filled, fully compensated
- 12 - - - Class II, vapor actuated, adjusted
- 13 - - - Class III, gas filled, fully compensated.

2. **Bulb Number** -

a. **Convertible Bulb** - The first 3 number groups give the bulb specification, the last group gives length of tubing in feet.

b. **Non-convertible bulb** - (such as (1), fig. 1) The first group of numbers gives bulb type, the second group gives tubing length in feet, the third group gives bulb specification.

3. **Bulb Elevation** - (Class II only) If the thermometer has been ordered corrected for levels, the elevation of bulb above or below instrument, measured to the bottom of its case, will be given. If these spaces are blank, no correction has been made. See Section g page 14 for full explanation of correction for levels.

C. **GENERAL INSTALLATION INSTRUCTIONS.**

Proceed as follows:

1st. **Install the case.** See front Index Page for "Case Mounting Dimensions". Thermometers must be mounted exactly plumb. Use a spirit level on **inside** bottom of case, or a plumb bob along front edge. Locate case to avoid extremes of temperature.

All Bristol's thermometers are compensated by means of bimetallic strip (23) to read correctly for ambient temperatures (surrounding air temperatures) at the case from 50 to 110 deg F (10 to 43 deg C). Thermometers can be factory compensated for other ambient temperatures if so ordered.

In flush mounting bottom connected thermometers on thick panels, it may be necessary to increase length of panel cut out

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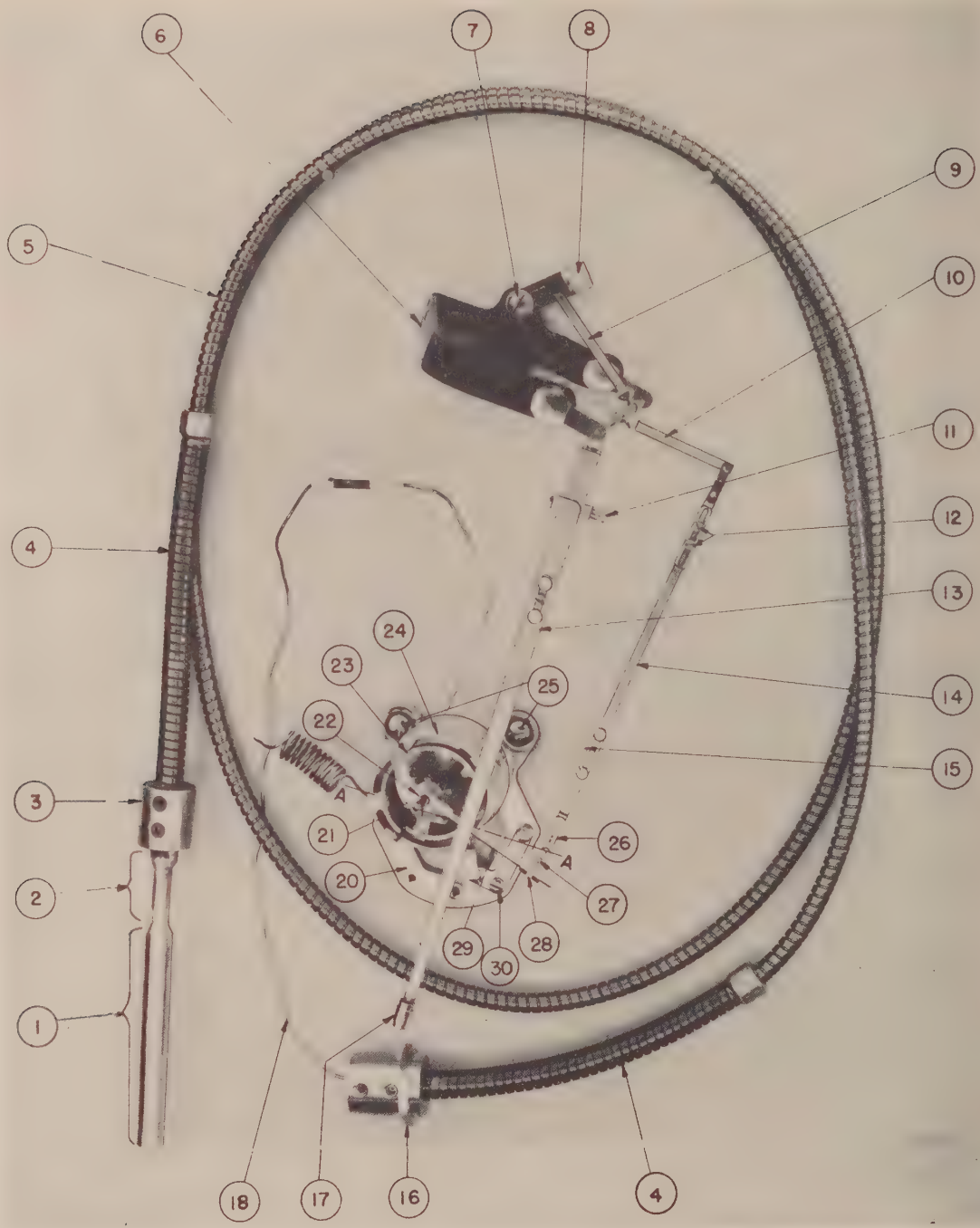

Fig. No. 1. Typical Thermometer System Showing over Range Pen Stop and Spring Link.

Code to Figure 1

1. Sensitive portion of bulb
2. Insensitive neck of bulb
3. Bulb head
4. Reinforcement Armor (2)
5. Flexible-armor
6. Universal pen mounting
7. Universal pen mounting screws (2)
8. Adjustable pen stop (optional equipment)
9. Pen stop lever (optional equipment)
10. Pen shaft lever
11. Point micro adjuster
12. Connecting link adjustment screws (2)
13. Pen Arm
14. Connecting Link
15. Expansion link spring (optional equipment)
16. Case connection fitting
17. Recording Pen (may be either V or fountain type)
18. Capillary tubing
20. Element Mounting Bracket
21. Split Hub Set Screw
22. Split Hub
23. Bimetallic Case Temperature Compensator (not used in Class II or fully compensated systems)
24. Thermometer Pressure Element
25. Element Mounting Bracket Screws (2)
26. Connecting link tab
27. Span Adjustment lock screw
28. Span Adjustment
29. Threaded lever
30. Element Mounting Screws (2)

-continued from page 3-

to provide clearance for tubing. See "Case Mounting Dimensions", front Index Page.

2nd. **Uncoil tubing** and **carefully** straighten it out without twists or kinks. **Do not cut it** under any circumstances.

3rd. **Install Bulb** - Be sure all moving parts of thermometer (i.e. pens, pointers or controller links) are free to move before installing bulb in process (i.e. tank, oven, pipe, etc.) See Section F below for details of bulb installation.

WARNING. NEVER SUBJECT BULB TO TEMPERATURES BELOW OR ABOVE ITS RANGE (unless its system is protected against such temperatures). To do so may destroy calibration and may permanently damage thermometer. This applies not only when thermometer is in use, but equally during **shipment** or **storage.**

4th. **Install Tubing.** Tubing may be strung thru conduit if bulb is small enough to pass thru it. Tubing may be supported on any wall, beam, etc., by fastening every 2 feet with clips, staples, etc. Tubing may be tied or taped to unheated pipes, columns etc. The tubing must be protected from mechanical damage, crushing, abrasion, strain or movement. **Do not bend tubing at less than 3" radius.** Do not subject tubing covered with polyvinyl chloride plastic to temperatures over 160 deg F (71 deg C) or it will melt.

Class I and III uncompensated tubing must be installed to avoid extremes of temperature. Keep tubing away from hot or cold pipes, ovens, chimneys, hot or cold air ducts, open windows, direct sunlight, etc. (See Section J below for effect of Class of thermometer on tubing installation.) Class II tubing is relatively unaffected by ambient temperatures.

Coil any excess of tubing in an 8" to 12" coil near the instrument and tape it in place. **Do not cut out excess tubing!**

5th. Thermometer is ready for operation. See front Index Page under "Recording System" for instructions on pen, chart, chart drive etc.

D. TYPE OF BULB TO USE.

1. **Plain Bulbs** (see fig. 2) can be used where a pressure tight joint is not necessary.

2. **Union Bulbs** (see fig. 3) are used where a pressure tight joint is necessary.

3. **Socket Bulbs** (see fig. 4 are used to:

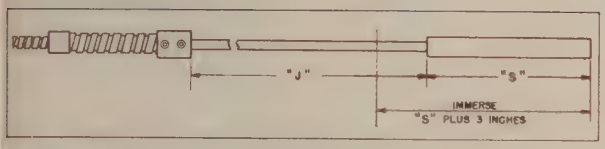

Fig. No. 2. Plain Type Thermometer Bulb

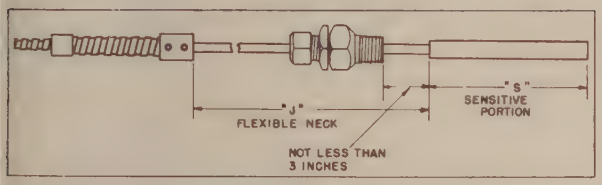

Fig. No. 3. Union Type Thermometer Bulb

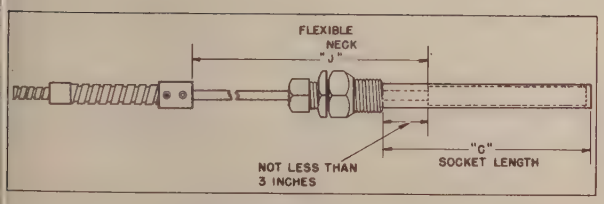

Fig. No. 4. Socket Type Thermometer Bulb

-over-

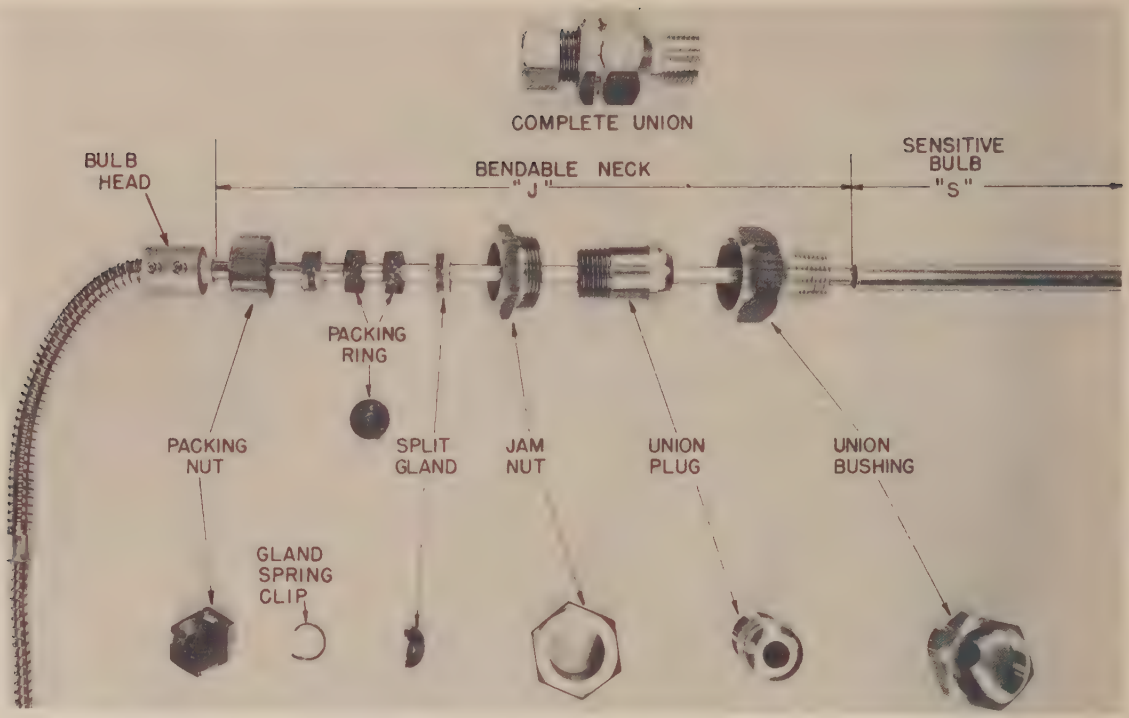

Fig. No. 18. Bristols Convertible Bulb showing Correct Order of Parts Assembly.

a. Protect bulb from corrosion.

b. Protect bulb from high pressure, mechanical damage or erosion.

c. Permit removal of bulb from process without necessity of turning process off. **Sockets should always be used where process cannot be shut down at any time for removal of bulb** for check, calibration, repair or replacement.

E. BRISTOL'S CONVERTIBLE THERMOMETER BULB.

1. Convertible Form. (see fig. 18) By exchange of union and socket parts, any convertible bulb can be changed to plain, union or socket types using only a wrench. Thus, one basis bulb can fulfill requirements of almost all processes. This feature permits standardization of thermometer systems to a single basic bulb specification throughout an entire plant, which allows quick replacement of a faulty system by standardized standby thermometers.

2. Assembly. Figure 18 shows correct order of part assembly. To change from plain (fig 2) to union bulb, (fig 3) the parts shown in figure 18 are added to plain bulb. To change from union to socket bulb, replace union bushing with socket.

All parts can be slipped over the sensitive bulb, except the packing and glands, which are split so they can be opened to slip over the neck. Halves of split glands are held together by spring wire gland clips. All bulb conversion parts are specified in "Parts List for Thermometer Accessories", See Index Page.

WARNING: In tightening jam nut, **be very careful not to mar the polished seat of union plug.** A damaged union seat will leak. Use only engineer's wrenches of exact size on the union plug nut. **Do not use toothed pipe wrenches.**

3. Bendable Neck. The $\frac{1}{4}$ inch diameter neck ("J" in figure 2 or 18) is standard in 10, 30 and 60 inch lengths. This neck can be bent, either inside or outside the process to clear pulleys, levers, stirring paddles, sliding doors, etc., to suit the installation. **Minimum radius of bend must be not less than 1 inch.** Bend neck around a pipe of proper diameter to avoid flattening. See figures 6, 8, 9 and 10, etc., illustrating use of bendable neck feature.

4. Installation Thru Conduit & Partitions Because all union and socket parts can be removed from convertible bulbs, leaving as the largest part on all but a few types the 3/4 inch diameter bulb head, it is

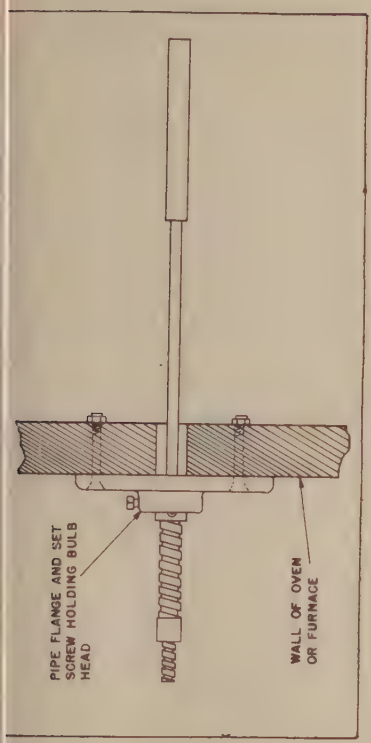

Fig. No. 5. Plain Bulb Installed in Wall of Oven

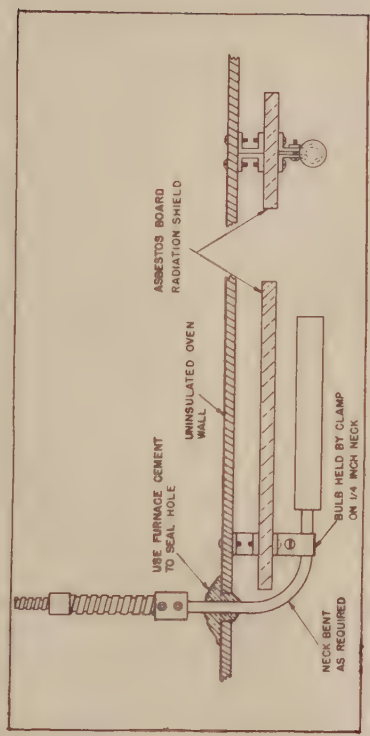

Fig. No. 6. Plain Bulb Clamped to Wall or Roof of Oven Showing Use of Radiation Shield.

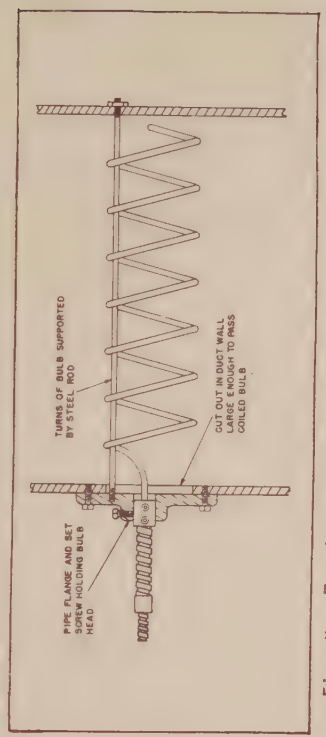

Fig. No. 7. Averaging Type Bulb Installed in Stack or Duct.

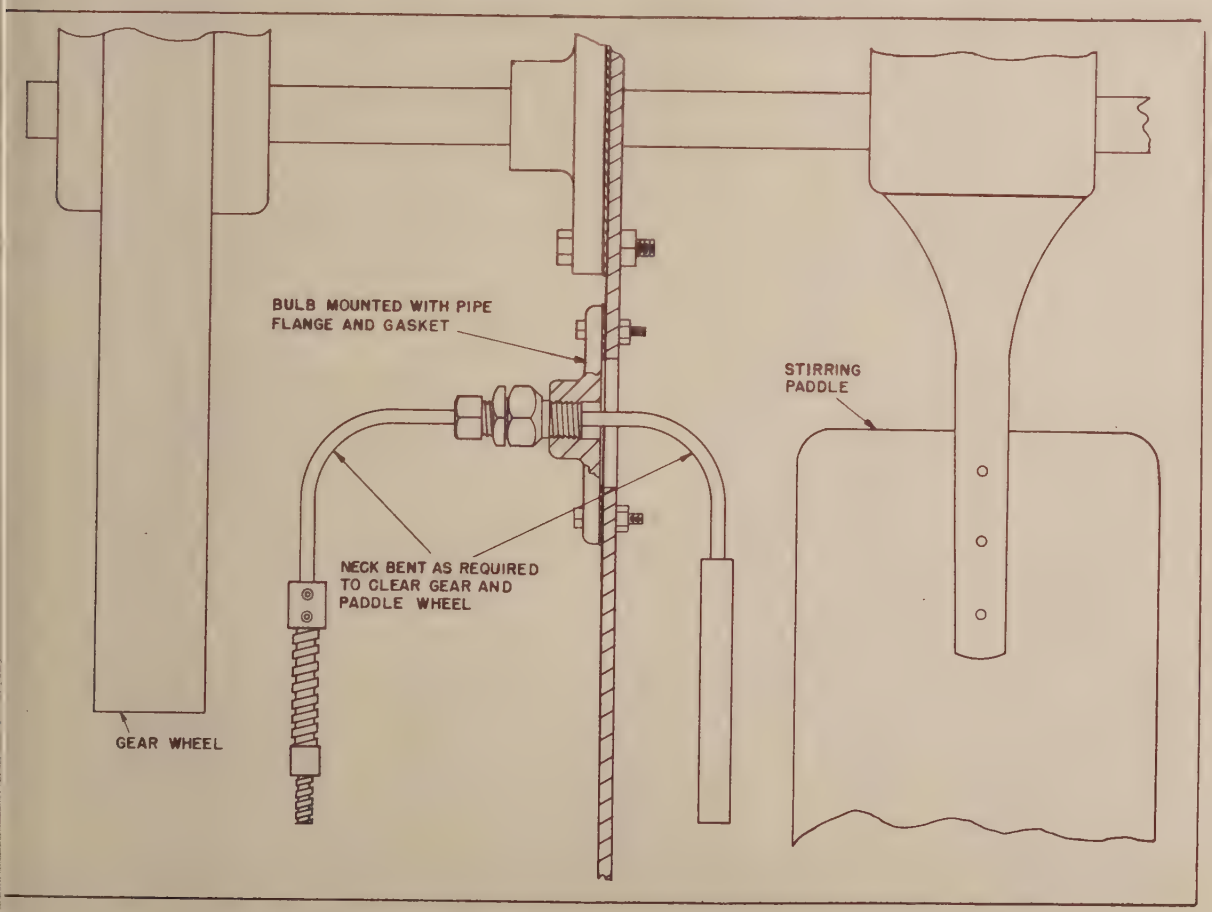

Fig. No. 8. Union Bulb Installed in Tank Showing Use of Bendable Neck.

possible to install tubing thru 3/4 inch conduit pipe for protection, or to pull tubing thru 3/4 inch holes in partitions or floors.

5. Variable Immersion. The convertible bulb can be immersed into the process a variable amount, limited only by length of neck "J", by means of the adjustable union. (See figures **9 & 11**) **The entire sensitive portion "S" of bulb must be immersed at all times in medium being measured.**

6. Effect of Immersion on Calibration. Convertible bulbs are factory calibrated with sensitive portion "S" **and 3 inches of neck "J"** covered by test bath. If specified on order, convertible bulbs will be calibrated with any length of neck immersed. If more than 3 inches of neck is immersed in medium being measured, slight errors may occur in some types of systems.

If strict accuracy is desired, Thermometer should be recalibrated with both bulb and immersed portion of neck or tubing covered by test bath. See Part III, section A for full calibrating instructions.

Union fittings will be supplied mounted 3 inches from bulb, unless otherwise ordered.

7. Amount of Immersion (see section 3, Page 11). To minimize conduction error, observe the following:

a. Install plain and union bulbs with not less than 3 inches of neck "J" inside process. (See figure 2)

b. Select sockets long enough to enclose not less than 3 inches of neck "J" (See figure 4)

c. After bulb is installed, insulate packing nut, jam nut & union bushing or socket, and adjacent area of process wall with a covering of asbestos cement. (See figure 14)

8. Pressure Limits of Convertible Bulb. Union bulbs can be used with ample safety factor up to 200 pounds per square inch (14.0 kilograms per sq. cm.).

Sockets can be safely used up to following:

	P.S.I.	K/SQ.CM
Bronze Sockets	500	35.0
Stainless Steel Sockets	750	52.6

F. INSTALLING BULBS

1. Plain Bulbs can be most easily held by clamping at the bulb head (3) (See figures 5, 6, 7 & 9 They can be suspended by wire or light chain or slipped into protection wells. (see fig. 10)

Note: If strict accuracy is required and it is necessary to immerse into the medium being measured more than 3 inches of bendable neck "J" (fig. 2) or of the tubing (5) of an uncompensated system, the thermometer should be recalibrated with bulb and immersed portion of neck or tubing covered by test bath. Where the amount of immersion is constantly changing (example-tank with varying level) calibrate bulb for average immersion. See Part III section A for full calibration instructions.

Caution: Do not immerse flexible armor (4 or 5) even momentarily in corrosive mediums, for the medium will penetrate joints in armor and destroy the capillary (18).

2. Union Bulbs can be installed thru tank or oven wall as in figures 8 and 11, or in pipe elbows or tees as in figure 13 or 14. To install, insert union bushing in process and screw up tight. Then, insert bulb and screw up jam nut tight, being careful not to twist tubing as jam nut is turned.

Warning: Be very careful **not to mar the seat** on the union plug. A damaged seat will leak. **Do not use toothed pipe wrenches.**

3. Socket Bulbs can be installed in tank wall, pipe elbow or tee, see figure **12** or **15**. To install, screw socket tightly into process. Then, insert bulb into socket and tighten jam nut, being careful not to twist tubing as nut is turned.

4. Immersion. The entire sensitive portion "S" of bulb plus 3 inches of neck "J" (see fig 2) must be covered by the medium being measured. If this is not done, the thermometer will not read correctly, because Bristol's thermometers are calibrated with full sensitive portion of bulb plus 3 inches of neck immersed. (See Section 6 above for full discussion of convertible bulb immersion.)

G. FACTORS AFFECTING THERMOMETER PERFORMANCE

- The following considerations are especially important where temperature critical processes are involved, and for controlling thermometers.

1. Bulb Location

a. Representative Temperatures. In selecting bulb location, consider what temp-

-continued-

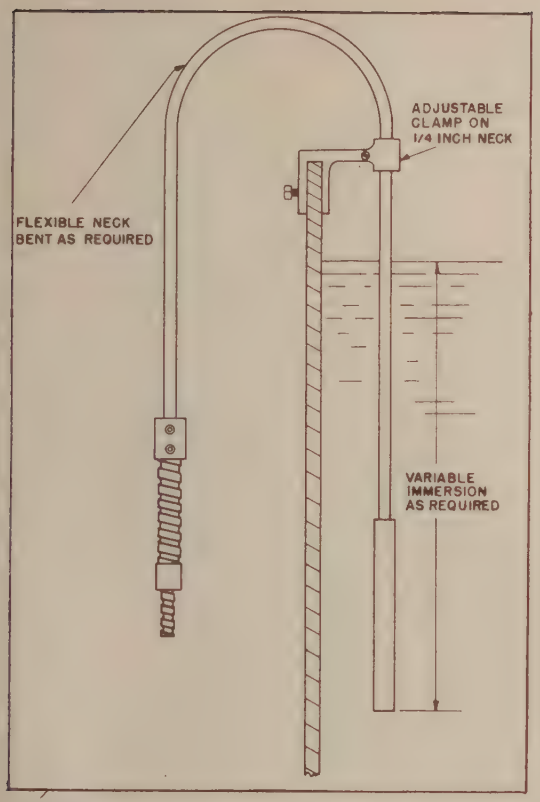

Fig. No. 9. Plain Bulb with long neck suspended by clamp in open vat or tank.

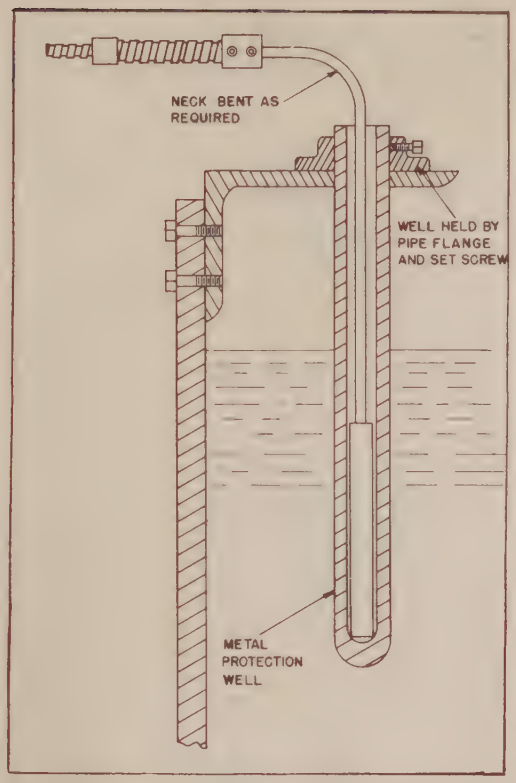

Fig. No. 10. Plain Bulb in Protection Well for Protection Against Molten Metals, Corrosive Chemicals, etc.

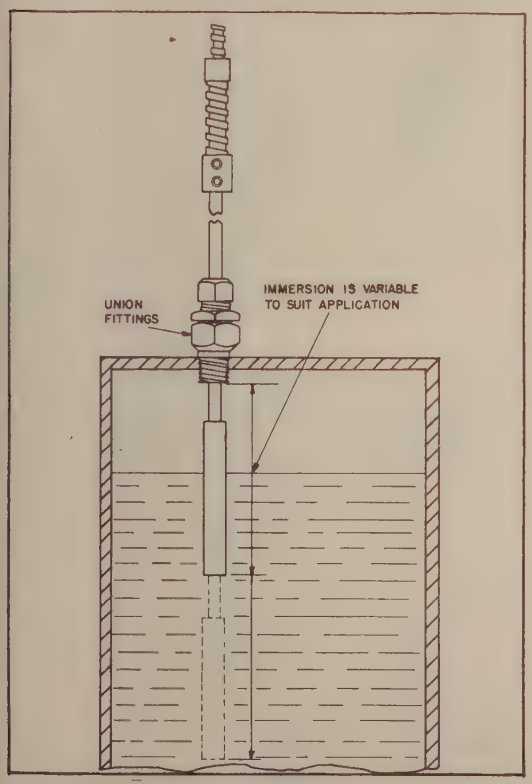

Fig. No. 11. Union Bulb Installed in Tank Showing Variable Immersion Feature.

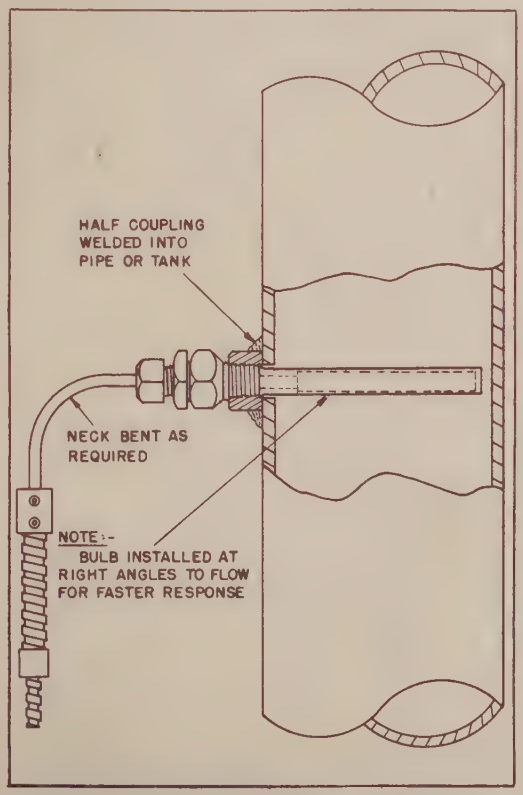

Fig. No. 12. Socket Bulb Installed in Pipe

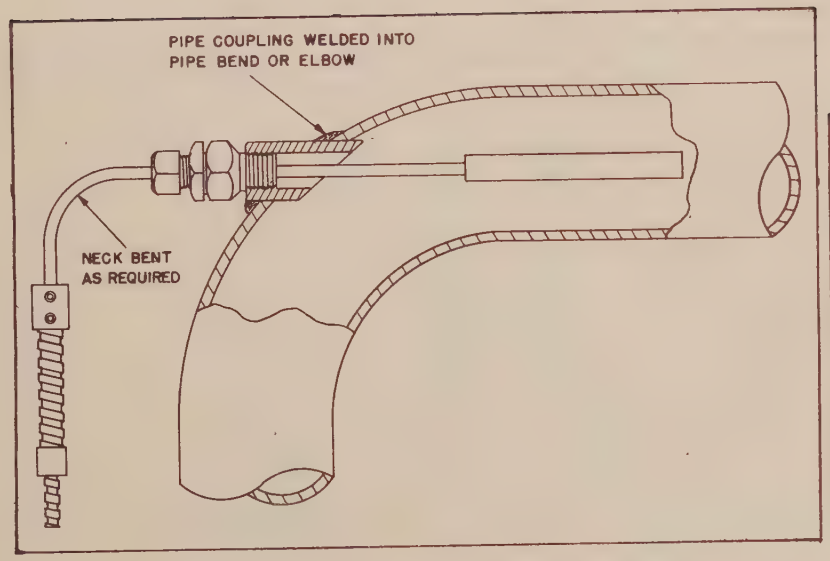

Fig. No. 13. Union Bulb Installed in Pipe Bend

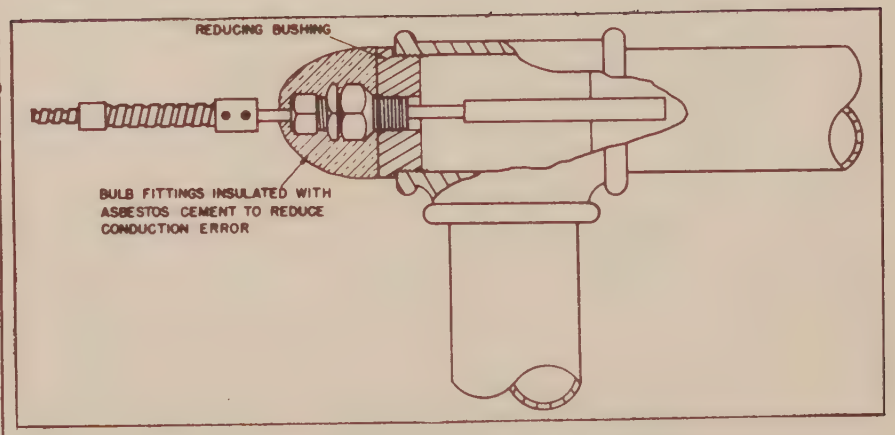

Fig. No. 14. Union Bulb Installed in Pipe T, Showing Insulation to Reduce Conduction Errors.

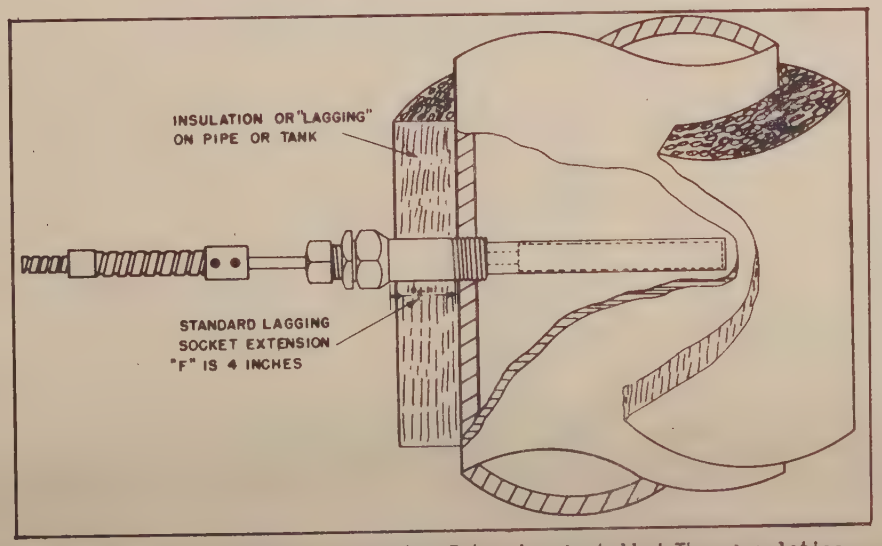

Fig. No. 15. Socket with Lagging Extension Installed Thru Insulation of Pipe

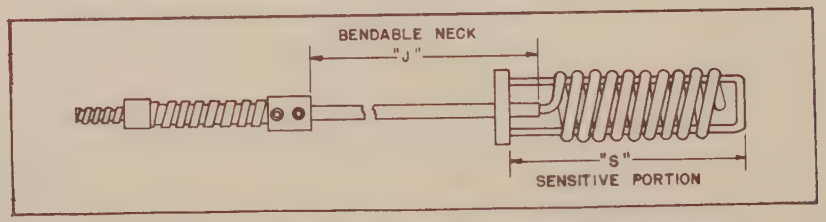

Fig. No. 16. High Sensitivity Bulb for Fast Response

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erature of the process you want to measure, i.e. maximum, average, minimum, or input, output or interior temperature. Interior temperatures of processes such as ovens, tanks, etc., may vary widely from point to point. Of first importance, is location of bulb so that it acquires that temperature it is desired to measure. A test to find this location can be made by moving the bulb from point to point and observing readings before a permanent installation is made.

Keep bulbs away from cooling or heating duct openings or heating or cooling coils. Keep bulb away from extreme top or bottom of ovens, rooms, etc., unless temperature of these points is desired.

. **Circulation.** Turbulence of measured medium around the bulb should be high to increase rate of heat transfer. Avoid locating bulbs in dead spaces, corners, dead end pipes or spots shielded from circulation. Avoid locating bulb so near bottom as to be covered by sludge. Place bulb near paddles, blowers, etc. Place bulbs in pipes or ducts at right angles to flow or stream. (see figure 12 & 14).

. **Radiation Error.** This is an important and usually overlooked consideration. Avoid placing bulbs where high temperature radiation from unshielded electric or steam heating coils can strike them. Avoid placing bulbs close to cold surfaces such as an uninsulated oven wall. If bulbs must be so located, place a piece of asbestos board or sheet metal between bulb and hot or cold surface to shield radiations. (see Fig 6).

In general - locate bulb to obtain good circulation, but not in direct path of heating or cooling agent.

. **Bulb & Socket Conduction** - Speed of response of a bulb is determined by its total mass, specific heat, conductivity, and volume to area ratio.

. **Bulb Shape.** The fastest responding bulbs will have largest area to volume ratio. Therefore, long, small diameter bulbs are preferable to short, thick ones. Bristol makes special highly responsive bulbs for applications requiring maximum speed of response. (See Figure 16)

. **Bulb Metals.** Speed of heat transfer depends upon bulb wall thickness and kind of metal. Bristol's thermometers use relatively low internal pressures, permitting use of thinner bulb walls, and copper alloys. Always use copper bulbs wherever possible. (see Fig. 17)

Avoid use of thick, steel or stainless steel bulbs such as are necessary for high pressure mercury filled thermometers.

Fig. 17. Comparative Heat Conductivity of Common Thermometer Bulb and Socket Metals.

Metal	Relative Speed of Heat Conductivity (approximate)
Copper	1
Aluminum	1/2
Brass	1/5
Bronze	1/5
Cast Iron	1/9
Steel	1/9
Lead	1/12
Monel	1/20
Stainless Steel	1/20

Note: Copper bulbs should never be used over 600 deg F (315 deg C) as copper becomes slightly porous and oxidizes rapidly at higher temperatures. Copper bulbs in steel sockets should not be used over 600 deg F (315 deg C) because, due to dissimilar expansion of the two metals, copper bulb will swell and may not be removable from socket.

Other considerations aside, bulbs and sockets of smallest mass, thinnest wall thickness, largest area and highest heat conductivity should always be selected. However, if the heat transfer from medium being measured is low, it may be advantageous to use sockets of low conductivity to minimize socket conduction errors. (see below).

c. **Filling Sockets.** Protection of bulbs by sockets is accomplished only by great decrease (loss of responsiveness may be as high as 30 to 1) in speed of response of the bulb.

The additional metal thickness and insulating effect of the dead air space between bulb and socket cut down rate of heat transfer very much. Therefore, bulbs should fit very snugly into sockets. A worthwhile increase in bulb response can be had by filling space between bulb and socket with a highly conductive medium such as water, oil, glycerine, graphite grease, mercury (only in all steel combinations), etc., depending upon the temperatures.

3. **Conduction Errors** - Heat is conducted away from all thermometer bulbs by the neck & capillary, thru union or socket fittings and escapes to wall of process or to ambient medium outside. Such loss of heat creates error by lowering bulb temp-

-over-

erature below that of process medium being measured.

The amount of conduction error depends upon

a. Thermal conductivity of neck and union or socket fittings

b. Length of heat path between bulb and ambient medium or process wall.

c. Rate of heat transfer of medium being measured.

It is to minimize conduction errors by lengthening heat path that minimum immersions of section 7 page 8 are recommended.

The rate of heat transfer of measured medium is governed by its specific heat and velocity past bulb or socket. The rate of heat escape along neck and thru fittings is a constant, but the rate of heat transfer varies widely between different media. In extreme cases, ambient temperature outside process may influence bulb temperatures almost as much as measured medium temperatures within. Thus, it may actually be advantageous to use socket metals of low conductivity to minimize conduction error.

For example, in temperature measurement of outdoor gas pipe lines, while medium velocity is high, specific heat is low. The wide variations in weather (ambient) temperatures, may cause serious discrepancies in gas temperature reading due to conduction error. Bristol makes special bulbs and sockets for such applications using copper (high conductivity) for bulbs and stainless steel (low conductivity) for neck and union fittings.

H. OVER AND UNDER RANGE PROTECTION:

(Refer to figure 1). As bulb (1) temperatures vary, internal pressures of the thermometer system change, causing pressure element (24) to coil or uncoil, actuating the linkage and pen arm (17).

Considerable force is developed by pressure element. If bulb temperature goes over upper limit of temperature range or under lower limit, pen will attempt to follow and be swung off chart or scale at either end. This pen motion would eventually be stopped by chart hub or side of case, probably bending pen arm (13) or linkage, destroying calibration of thermometer.

To protect pen arm and linkage against such damage, adjustable stops (8) are provided to limit pen travel to little more than full range. Connecting link (14) is provided with a compression and expansion spring (15) which permits element (24) to move beyond range after lever (9) strikes stop (8).

Bristol's thermometers will be supplied with this over range and/or under range protection when so ordered.

Note, that even with such protection to pen and linkage, the pressure element may be extended beyond its elastic limit and its calibration destroyed by excessively large over or under range temperatures. The maximum possible limits of over and under range temperature protection vary with class and range, length of tubing and ambient temperature. Please consult Sales Engineering Department, at main Waterbury factory for such data.

Warning: **Never subject a thermometer bulb to temperatures over or under its range unless its system is protected.** It is often overlooked that this precaution applies to many thermometers of high partial range, while instrument is in storage or shipment.

J. INSTALLATION CONSIDERATIONS DEPENDING ON CLASS OF THERMOMETER.

There are several important differences to be observed when installing the three different classes of thermometers.

Also, there are installation differences between case compensated and fully compensated thermometers.

I. Class I Liquid Filled.

a. Tubing Ambient Temperatures. Case Compensated Class I. Case compensated Class I thermometers are constructed with bimetallic strip (23) which compensates for ambient temperatures at the case only. Case compensated Class I thermometers are particularly affected by variations in ambient temperatures along capillary tubing, so great care must be used to install tubing away from hot or cold locations. (See 4th step page 5) No longer than 10 feet (3 meters) of capillary tubing should ever be ordered or used with case compensated Class I thermometers. The immersion of the "J" neck is very critical with case compensated Class I.

Fully Compensated Class I. These thermometers are constructed so as to compensate for both tubing and case ambient temperatures. Fully compensated thermometers are not affected by ambient temperatures or length of tubing over wide limits. Therefore, where tubing ambient temperatures will vary or where long tub-

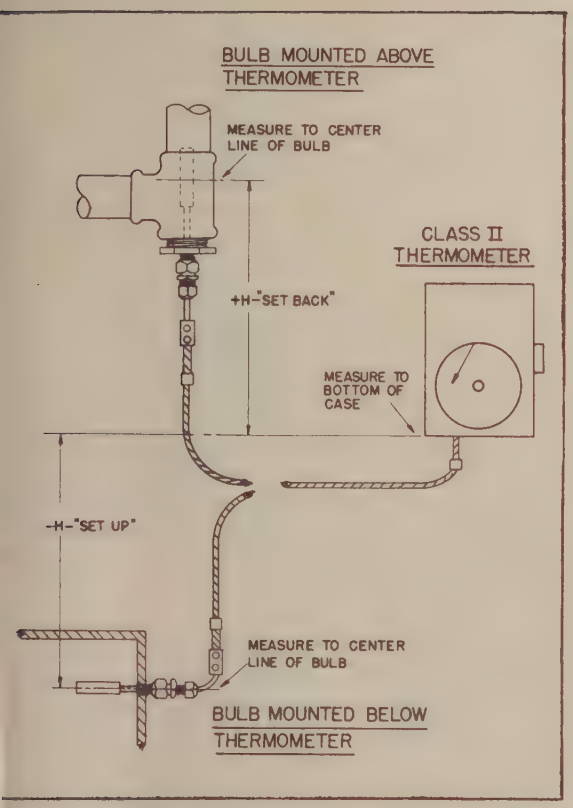

Fig. No. 19. How to Measure for Class II Thermometer Bulb Level Correction.

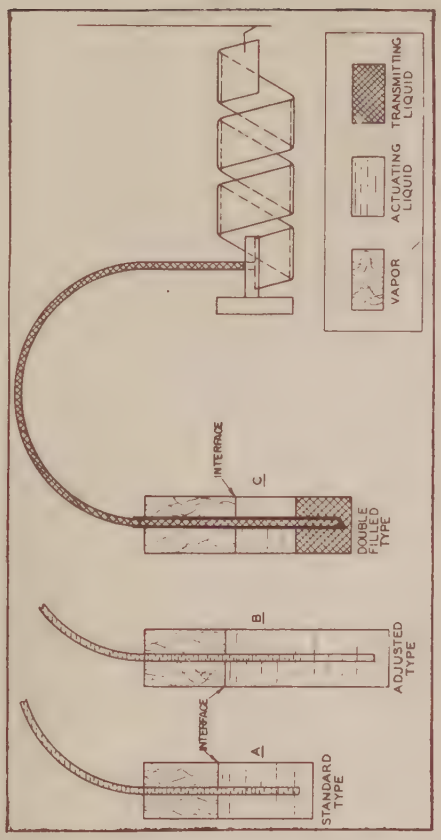

Fig. No. 20. Class II Vapor Pressure Bulbs.

ings (over 10 feet - 3 meters) are required in a liquid filled system, fully compensated Class I Thermometers should always be used.

It is only common sense, even with full compensation, to install instrument in a location with most uniform temperatures possible and order the minimum possible tubing lengths.

There are definite limits to the maximum amount of ambient temperature variation which can be compensated for even in Fully Compensated Class I Thermometers. These limits depend upon length of tubing used.

Please consult Bristols' Sales Engineering Department at main Waterbury factory for such data. If ambient temperature limits are stated on orders, it is usually possible to compensate Class I thermometers accordingly during manufacture.

b. Over and Under Range Protection. A Class I pressure element **always** responds to temperature changes whether these temperatures lie inside or outside of the thermometer's range. Therefore, Class I thermometers must always be provided with over and /or under range protection where bulb temperatures outside range limits are possible **at any time,** whether during use or during shipment or storage. (See section H page 12).

2. Class II Vapor Actuated.

a. Principles of Class II. The Class II system is partly filled with a liquid and remainder is filled with the vapor of that liquid. (See figure 20). At some point in the system there exists the dividing surface between liquid and vapor called "interface". **The pressure developed in the system depends only on the temperature at this interface.** Thus the system measures temperatures at the interface only and is insensitive to temperatures of those parts of system which are completely vapor filled or completely liquid filled. Because of the above, Class II thermometers are relatively unaffected by ordinary temperature changes along tubing or at case. Therefore, no bimetallic case compensator (23) is required and less particular care need be observed in locating capillary tubing.

b. Cross Ambient Affect. The Liquid in

-over-

Class II System will condense in coldest part of system, leaving rest of space vapor filled. When bulb is hotter than tubing, liquid will condense in tubing; when bulb is colder than tubing, liquid will condense in bulb. Therefore, when bulb temperatures go from above to below tubing and element ambient temperatures or visa versa, an unstable condition occurs caused by exchange of liquid and vapor between bulb and tubing. This is called "cross ambient affect" because it occurs each time bulb temperatures cross over tubing and case ambient temperatures,

If bulb volume is smaller than volume of liquid fill, the bulb will be unable to hold all liquid. Then, when bulb is colder than tubing, liquid will fill bulb completely and interface will exist in capillary. The bulb will no longer control the temperature measured and thermometer will read ambient temperature of tubing.

Likewise, if volume of liquid fill is less than volume of tubing plus element, interface will exist in capillary when bulb is hotter than ambient temperature.

c. Standard Class II. In these systems no particular care is observed in proportioning bulb to liquid volume. Therefore, Standard Class II Thermometers can be filled to accurately measure bulb temperatures **only when bulb is continuously higher or continuously lower** than tubing or case ambient temperature. Therefore, **Standard** (i.e. unadjusted) **Class II thermometers should be used only where bulb temperatures will always be either several degrees higher or several degrees lower than ambient temperatures.**

d. Adjusted Class II. If the amount of liquid fill is greater than volume of tubing plus element, and bulb volume is greater than amount of liquid, the interface will always exist in bulb whether bulb is above or below ambient temperatures. This is accomplished by adjusting bulb and fill volume in proper proportion to length of tubing used. Such systems are called "Adjusted Class II".

The adjusted Class II thermometer will measure correctly **both** above and below ambient temperatures, although it will be unstable for several degrees either side of ambient temperatures. Note that bulb must be mounted at approximately same level as case, so that level errors do not occur when liquid and vapor exchange between bulb and tubing. (See Section g. below)

Therefore, never use an adjusted Class II thermometer for accurate measurements close to ambient temperatures, or in applications requiring difference between case & bulb elevation.

e. Dual Filled Class II. In this type, entire pressure element and capillary tubing are filled with a transmitting liquid (See figure 20). All actuating liquid and all vapor and consequently the interface are always in bulb, so thermometer is always sensitive only to bulb temperatures. Since actuating liquid and vapor do not exchange, no change in level errors occur at cross over temperatures. Therefore Dual Filled Class II systems can be used for accurate measurements above, thru and below ambient temperatures regardless of bulb elevation. Note that an initial correction for bulb elevation must be made to Dual Filled Systems after installation.

f. Over Range Protection. The pressure inside Class II systems increases in logarithmic relation to temperature (which accounts for their increasing scale characteristic). Therefore, over range temperatures produce dangerously high pressures which may damage instrument. Do not use Class II thermometers where over range temperatures are possible unless system is provided with protection. (See section H page 12). Under range protection is seldom required because pressure in system is nearly zero at low end of range.

g. Correction for Bulb Level. (See figure 19). In the majority of thermometer installations, bulb is at higher temperatures than tubing so tubing will be filled with the liquid (all vapor will be in bulb). When bulb is mounted at level above or below thermometer case, the weight of this liquid in vertical portions of tubing adds to or subtracts from pressures in element (24). Because pressures in vapor filled systems are low, this plus or minus head of liquid ("h" in figure 19) may cause a serious error in temperature readings which must be compensated for.

When bulb is mounted above case, weight of liquid in tubing "+h" will **add** to pressure measured by element (24), causing thermometer to read high. To read correct bulb temperature, thermometer reading must be "set back".

When bulb is mounted below case, weight of liquid in tubing "- h" will **subtract** from pressure measured by element (24),

causing thermometer to read low. Then to read correct bulb temperature, thermometer reading must be "set up".

Note that **when bulb is always colder than tubing** (i.e., bulb is always below ambient temperature), fluid will all condense in bulb leaving tubing filled with vapor and **no correction for difference in bulb and case level will be necessary.** (except with double filled systems).

Also note, that **when bulb is both sometimes colder and sometimes hotter than tubing** (i.e. bulb is sometimes above and sometimes below ambient temperatures) tubing will be sometimes filled with liquid and sometimes filled with vapor, so **corrections for levels are impossible** with a standard or adjusted system. Adjusted systems will be accurate both above and below ambient temperatures only when bulb is approximately at same level as case.

When so ordered, Class II thermometers will be factory calibrated to correct for any specified bulb elevation. If a thermometer has been so corrected in factory, its name plate will list the bulb elevation in feet. (See section B-3 page 3). The difference in bulb and case level is always measured from **center line of bulb to bottom of case,** as shown in figure 19. **If possible, always order Class II thermometers with bulb elevation specified** so that level correction can be made in the factory.

How to Make Level Corrections in the Field. If it is necessary to make or change level correction in the field, two methods can be used.

1. Comparison with Test Thermometer. When thermometer has been installed, place thermometer bulb and accurate test thermometer in a test bath **located at same level as that at which bulb will be mounted.**

By turning point adjuster (11) (Figure 1), bring thermometer pen or pointer to agree with test thermometer. This method can also be used in laboratory calibration if thermometer case is placed above or below bulb during regular calibration procedure (See section A page 19 for calibration details).

2. Setting Pen by Correction Factor. If the above method is impractical, level correction can be made at any time while thermometer is installed or during calibration from data of figures 21 and 22 as follows:

1st. Carefully measure difference in level between **center line of bulb** location and **bottom of thermometer case** (see fig. 19).

2nd. Select correction factor from proper column of figure 21 or 22 corresponding to chart or scale range of thermometer concerned. Note that listed factors are for **10 feet difference** in elevation.

$$\text{Pen correction (in inches)} = \pm \frac{\text{Bulb Elevation (in feet)}}{10} \times \text{factor from figure 21 or 22.}$$

3rd. Bring thermometer reading to any convenient steady value.

4th. Using a finely graduated foot rule, set up or set back pen the required fraction of an inch, by turning point adjustment (11).

Example: Bulb elevation 18 feet above bottom of case, chart number 22004, range 50 to 200°F. From column "bulb mounted above case-set back" (figure 21) obtain 0.162 inches (exact correction). To obtain pen correction for **18 feet:**

$$\text{Pen correction (inches)} = \frac{18}{10} \times 0.162''$$

$$= 0.291'' \text{ (approx. } \frac{19}{64} \text{ ths.)}$$

While thermometer is **steady** at any convenient temperature, say room temperature of 75°F, measure $\frac{19}{64}$ ths inch down range from 75° with an accurate steel rule. Turn point adjuster (11) until pen reading has been set back by this $\frac{19}{64}$ ths inch amount.

3. Class III Gas Filled.

a. Case Compensated Class III. Case compensated Class III thermometers are constructed with bimetallic strip (23) which compensates for ambient temperatures at the case only. Class III case compensated thermometers are affected by ambient temperatures along tubing, so care must be used to avoid hot and cold locations when installing tubing (See 4th step, page 5). For a given bulb size, the length of capillary tubing which can be used with accurate results varies with temperature span.

b. Fully Compensated Class III. Fully compensated Class III thermometers can be made to order which compensate for both long tubing lengths and wide variations of ambient temperatures.

continued on page 18

Correction Factors for Difference in Level between Bulb and Case. **Class II Recording Systems Only.** Note: Corrections listed are for a **10 foot difference.** Use a proportional fraction of these corrections for level differences of more or less than 10 feet.

Chart Number	Chart Size in Inches	Temperature Range	Pen Corrections in Inches (for 10 ft.)			
			Bulb Mounted Above Case "Set Back"		Bulb Mounted Below Case "Set Up"	
			Exact Correction	Nearest 64th	Exact Correction	Nearest 64th
		FAHRENHEIT RANGES				
22007	12"	20-90	.2205	7/32	.2695	17/64
682	12"	23-95	.3465	11/32	.4235	27/64
28000	8"	0-100	.1131	7/64	.1309	1/8
3902	12"	60-110	.333	21/64	.407	13/32
633	8"	30-130	.1178	1/8	.1363	9/64
666	8"	30-130	.1178	1/8	.1363	9/64
1968	12"	60-140	.1692	11/64	.2067	13/64
660	8"	30-150	.0835	5/64	.0967	3/32
1934	12	30-165	.099	3/32	.121	1/8
22009	12"	30-165	.1143	7/64	.1397	9/64
618	12"	30-175	.0846	5/64	.1035	7/64
644	12"	30-175	.0846	5/64	.1035	7/64
1919	12"	30-175	.0846	5/64	.1035	7/64
676	12"	80-175	.1018	3/32	.1242	1/8
1922	12"	80-175	.1018	3/32	.1242	1/8
3801	12"	80-175	.1018	3/32	.1242	1/8
22012	12"	30-180	.099	3/32	.121	1/8
28008	8"	90-180	.0788	5/64	.0912	3/32
22001	12"	100-180	.1225	1/8	.1496	5/32
22008	12"	30-200	.1575	5/32	.1925	6/32
1944	8"	30-200	.1623	5/32	.188	6/32
22004	12"	50-200	.162	5/32	.198	13/64
22013	12"	50-200	.162	5/32	.198	13/64
22017	12"	80-200	.0792	5/64	.096	3/32
1917	8"	90-200	.102	7/64	.118	1/8
685	8"	100-200	.1095	7/64	.1268	1/8
657	12"	30-212	.1117	7/64	.1364	9/64
1932	12"	30-212	.1117	7/64	.1364	9/64
22015	12"	80-220	.0585	1/16	.0715	5/64
1913	8"	120-220	.863	5/64	.100	3/32
1920	8"	120-220	.0863	5/64	.100	3/32
637	8"	30-230	.0613	1/16	.071	5/64
661	8"	30-230	.0613	1/16	.071	5/64
1909	8"	30-230	.0613	1/16	.071	5/64
629	12"	30-230	.0917	3/32	.112	7/64
1904	12"	30-230	.0917	3/32	.112	7/64
1949	12"	30-230	.0917	3/32	.112	7/64
1975	12"	30-230	.0917	3/32	.112	7/64
22003	12"	50-230	.1062	7/64	.1298	1/8
1953	12"	70-250	.0747	5/64	.0914	3/32
1962	12"	70-250	.0747	5/64	.0914	3/32
3903	12"	70-250	.0747	5/64	.0914	3/32
1959	8"	80-250	.0492	3/64	.0569	1/16
.662	8"	30-270	.0882	3/32	.1020	7/64
.696	12"	30-270	.1323	1/16	.1618	5/32
1911	12"	30-270	.1323	1/8	.1618	5/32
634	8"	30-300	.0556	3/64	.0645	1/16
663	8"	30-300	.0556	3/64	.0645	1/16
686	8"	30-300	.0556	3/64	.0645	1/16
1946	12"	30-300	.0847	5/64	.1035	7/64
22010	12"	30-300	.055	3/64	.0671	1/16
22011	12"	30-300	.055	3/64	.0671	1/16
22008	12"	30-300	.055	3/64	.0671	1/16
22009	8"	100-300	.0370	1/32	.0408	3/64
28001	8"	200-300	.0516	3/64	.0569	1/16
1921	12"	200-300	.1020	7/64	.1242	1/8
28003	8"	220-310	.0486	3/64	.0537	3/64
1963	12"	140-320	.0675	1/16	.0825	5/64
1916	8"	200-320	.050	3/64	.058	1/16
1925	8"	200-320	.050	3/64	.058	1/16
664	8"	30-330	.0408	3/64	.0452	3/64
1991	8"	30-330	.0408	3/64	.0452	3/64

Figure 21 Level Corrections for Recording Thermometers

-continued-

678	12"	30-330	.0576	1/16	.0705	5/64
1929	12"	30-330	.0576	1/16	.0705	5/64
1942	12"	30-330	.0576	1/16	.0705	5/64
1957	12"	150-340	.0505	3/64	.0616	1/16
675	8"	30-350	.0287	1/32	.0332	1/32
1951	8"	30-350	.0287	1/32	.0332	1/32
1945	12"	30-350	.0432	3/64	.0528	3/64
28002	8"	200-350	.0418	3/64	.0484	3/64
22019	12"	200-350	.0576	1/16	.0705	5/64
1918	12"	100-360	.0477	3/64	.0584	1/16
1988	12"	100-360	.0477	3/64	.0584	1/16
1956	12"	225-375	.036	1/32	.044	3/64
1914	8"	30-400	.0147	1/64	.0172	1/64
1996	8"	30-400	.0147	1/64	.0172	1/64
1912	12"	30-400	.0252	1/32	.0308	1/32
636	8"	30-415	.013	1/64	.015	1/64
28005	8"	250-420	.1320	1/8	.1525	5/32
22025	12"	200-450	.1378	9/64	.1684	11/64
28004	8"	250-450	.102	7/64	.118	1/8
671	8"	30-500	.0492	3/64	.057	1/16
687	12"	30-500	.0747	5/64	.0913	3/32
1901	12"	30-500	.0747	5/64	.0913	3/32
1940	8"	100-550	.034	1/32	.0387	1/32
22020	12"	200-550	.0585	1/16	.0715	5/64
22022	12"	100-600	.0388	1/32	.0473	3/64
			REAUMUR RANGES			
692	8"	0-63°R	.0557	1/16	.0644	1/16
631	12"	0-63	.0837	5/64	.1025	7/64
635	12"	0-63	.0837	5/64	.1025	7/64
22005	12"	20-70	.090	3/32	.110	7/64
615	12"	0-88	.0837	5/64	.1025	7/64
624	12"	0-88	.0837	5/64	.1025	7/64
22014	12"	20-105	.0712	5/64	.087	3/32
			CENTIGRADE RANGES			
643	8"	0-50°C	.137	9/64	.159	5/32
1905	8"	0-55°C	.114	7/64	.132	1/8
1979	12"	25-65	.162	5/32	.198	13/64
1903	8"	20-71	.0835	5/64	.0967	3/32
28006	8"	0-75	.077	5/64	.089	3/32
1908	8"	0-80	.0553	1/16	.0643	1/16
1955	12"	0-80	.0837	5/64	.1025	7/64
1986	12"	0-80	.0837	5/64	.1025	7/64
22028	12"	30-80	.118	1/8	.144	9/64
632	8"	0-100	.076	5/64	.088	3/32
683	8"	0-100	.076	5/64	.088	3/32
665	12"	0-100	.115	7/64	.141	9/64
695	12"	0-100	.115	7/64	.141	9/64
22000	12"	60-100	.0945	3/32	.1155	7/64
1994	12"	0-104	.0468	3/64	.0572	1/16
1999	12"	0-104	.0468	3/64	.0572	1/16
1906	8"	0-110	.0603	1/16	.0697	1/16
1907	8"	0-110	.0603	1/16	.0697	1/16
1936	12"	0-110	.0918	3/32	.112	7/64
28007	8"	0-110	.0324	1/32	.0376	1/32
22026	12"	40-110	.123	1/8	.1485	9/64
1902	12"	0-130	.142	9/64	.174	11/64
674	12"	0-130	.142	9/64	.174	11/64
22016	12"	0-130	.0675	1/16	.0825	5/64
22027	12"	0-130	.0675	1/16	.0825	5/64
1939	8"	0-132	.0388	1/32	.045	3/64
1933	12"	25-145	.0945	3/32	.1155	7/64
630	8"	0-150	.0547	3/64	.0633	1/16
1971	8"	0-150	.0547	3/64	.0633	1/16
22024	12"	40-150	.0513	3/64	.0627	1/16
22018	12"	40-155	.0468	3/64	.0572	1/16
1943	12"	60-160	.0675	1/16	.0825	5/64
679	12"	0-165	.0576	1/16	.0705	5/64
1923	12"	0-165	.0576	1/16	.0705	5/64
1973	12"	30-165	.0576	1/16	.0705	5/64
1964	8"	50-165	.0388	1/32	.045	3/64
1948	8"	50-175	.0315	1/32	.0365	1/32
1937	12"	50-175	.0468	3/64	.0572	1/16
641	8"	0-185	.026	1/32	.030	1/32
1927	12"	50-195	.0306	1/32	.0374	1/32
677	8"	0-200	.0176	1/64	.0202	1/64
1960	8"	0-200	.0176	1/64	.0202	1/64
1952	12"	50-250	.0848	1/64	.1045	1/64

Fig. 21 - continued -

Figure 22. 8" Segment Scale Indicating Class II Thermometer Correction Factors for Difference in Level Between Bulb & Case.

Note: Corrections listed are for a **10 feet difference.** Use a proportional fraction of these corrections for level differences of more or less than 10 feet.

Scale Number	Temperature Range Degrees	Pointer Corrections in inches (for 10 feet)			
		Bulb Mounted above case "set back"		Bulb Mounted below case "set up"	
		Exact Correction	Nearest 64th	Exact Correction	Nearest 64th
5300	50-130F	.276	9/32	.320	21/64
5301	60-160F	.167	11/64	.193	3/16
5302	80-190F	.109	7/64	.127	1/8
5303	100-230F	.067	1/16	.077	5/64
5304	100-270F	.086	3/32	.100	3/32
5305	150-320F	.054	3/64	.061	1/16
5306	250-350F	.081	5/64	.094	3/32
5307	200-370F	.054	3/64	.061	1/16
5308	240-420F	.253	1/4	.293	19/64
5309	300-470F	.148	9/64	.172	11/64
5310	300-500F	.115	7/64	.133	9/64
5311	40-110C	.067	1/16	.077	5/64

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It is only common sense, even with full compensation, to install case and tubing in a location with most uniform temperatures possible and order the minimum possible tubing lengths.

c. Over and Under Range Protection. A Class III pressure element will **always** respond to temperature changes whether these temperatures lie inside or outside of the thermometer's range.

Therefore, Class III thermometers must always be provided with over and under range protection, where bulb temperatures outside range limits are possible **at any time whether in use or during shipment or storage.** (see section H page 12).

K. INSTALLATION OF CERTAIN SPECIAL BULBS.

1. Atmospheric Temperatures. Thermometers for measuring weather temperatures should be equipped with extra sensitive bulbs (similar to figure 16) in a weatherhouse. Best location for a weather bulb is in the shade on north side of a building (south side in southern hemisphere), at least 10 feet above ground and 2 feet out from wall, **not** opposite a window. For roof mounting, locate bulb on a pole not less than 8 feet above roof, preferably at a corner and in full sweep of wind from all directions. Do not mount bulb on chimneys, vents or near air shafts, sky lights, etc.

2. Averaging Bulbs. (See figure 7) Averaging bulbs are made with maximum area to volume ratio which results in maximum speed of response to change, an due to their large dimensions, ability measure average temperature over a lar area rather than at a point. Averagi bulbs are, for convenience, shipped in compact coil. **Do not pull out this coi** but unwind it turn by turn as you wou unwind wire from a spool. This will void twisting the bulb tubing, which mig crack it. The bulb may be complete straightened out and mounted in ove room or other process by clips or stapl as with any other tubing. Or, the bu may be used partially coiled and su ported by a rod as in figure 7.

Never cut, break or flatten any part averaging bulb tubing. Minimum radius bend 1 inch.

3. Electroplating Baths & Tanks. No pa of bulb or tubing can touch any electr cally conductive (metal) part of the ta or electrodes. All parts of the thermo eter case and tubing must be electrical insulated from ground.

We recommend bulb be installed on a wood support in the tank, and located betwe anodes and wall of tank. **Bulb or tubi must not be installed in direct line b tween anode and cathode.**

As voltage used in plating is low, ther ometer case and tubing can be insulated mounting on wooden panel & support

Conduits and air control piping (if an connected to the case must be insulat with plastic bushings.

PART II OPERATION

ressure type thermometers begin to perate as soon as the system is filled n the factory, and continuously operate hereafter. Therefore, no operating instructions are necessary. See Index Page for operation of recording and controlling systems (if any)

PART III SERVICE

te: This instruction covers service thermometer system only. See Index ge for service to all other parts of cording or Controlling systems.

CHECKING AND CALIBRATING

Testing for Friction. Be sure to elinate all friction before attempting to calibrate any thermometer. Under bad nditions of high humidity, corrosive mes, gum forming vapors, dust laden r, etc., a possible reason for loss of libration is corroded or dirty bearings thermometer system.

Overall Test for Friction. This test ould always be made before checking or librating as follows:

t. Immerse bulb in test bath and allow n or pointer to come to a final reading disturbed.

d. While watching pen or pointer osely, gently tap instrument case with st. If pen or pointer jumps to a new sition there must be friction somewhere.

Test for Element Shaft Friction.

. With fingers, gently move split hub 3) in and out. There should be a small ount of end play and bearing should ide very freely on shaft.

l. If not, take bearing apart without sturbing length of lever (29) or adstments (12),(27) or (28). To take rt bearing, loosen split hub set screw), slip hub off hollow bearing sleeve, ove 2 element mounting screws (30) and p element together with hollow bearing shaft. Clean bearing and shaft as section D page

. If bearing shaft has been accidenty bent, loosen set screw, remove shaft m mount and straighten by rolling beeen plane blocks.

. Reassembly in reverse order to are being sure that all parts move ely without binding.

. In controlling thermometers check o for friction all control links, ers, bearings, vanes etc., which are ed by the thermometer element.

Pen Pressure. Considerable friction can result if the pen point (17) bears too heavily on the chart. With fingers, bend pen arm (13) until pen touches chart with just enough pressure to trace properly.

2. Checking and Calibrating Procedure. There are two methods of checking the accuracy of pressure system thermometers.

1st. Point Adjustment. (Also called- "zero adjustment", micrometer screw adjustment", etc.) Thermometer is checked and adjusted at **one point** of its range only, which assures that it coincides with the standard thermometer at **one temperature only.**

2nd. Span Adjustment. (also called, "scale length", "range", "action", "ratio","multiplier", etc., adjustment). Thermometer is checked and adjusted at two points or more of its range, which assures that it coincides with the standard thermometer at **all temperatures** thruout its range. This adjustment changes span thru which pen travels for a given change in temperature.

a. Cautions for Calibration or Checking

BE SURE THERMOMETER CASE IS EXACTLY LEVEL.

USE ONLY A TEST THERMOMETER OF RECENTLY TESTED 1% OR BETTER ACCURACY AND RANGE CLOSE TO THAT OF THERMOMETER BEING TESTED.

WITH RECORDERS, MAKE READINGS ONLY FROM ACTUAL PEN TRACINGS QUICKLY OBTAINED BY LOOSENING CHART HUB AND TURNING CHART SLIGHTLY BY HAND.

Thermometers may be checked while installed or removed to shop or instrument laboratory. It is best to calibrate while installed for following reasons.

1. Saves time and handling of easily damaged tubing.
2. Automatically corrects for existing ambient temperatures along tubing and at case.
3. Automatically corrects Class II thermometers for difference in bulb and case levels.

STEP I. POINT CHECK & CALIBRATION.

1st. Remove bulb (1) from application. Remove socket or well (if any) from bulb.

2nd. Run thermometer up and down scale

-over-

3 or 4 times before checking readings, especially if system has been out of service for some time, by immersing bulb alternately in cold and hot test baths.

3rd. Place an armored, glass stem, test thermometer alongside bulb (1) so that two bulbs are as close together as possible, and tie with string.

4th. Immerse bulb & test thermometer in hot test bath. **Be sure the entire sensitive portion and no more is covered.** Note: If bulb will be used with a portion of its neck "J", or a portion of its capillary tubing immersed in the measured medium, that same portion should be covered by test bath. This will correct for immersion errors. (see section 6 page 8). Note that glass stem test thermometers are calibrated in two ways, one for total immersion and second for partial immersion, (in which case they will have an immersion mark etched into the glass stem). Be sure that test thermometers also are correctly immersed according to their calibration.

5th. Stir bath vigorously with a paddle **for at least 3 minutes each time** before readings. **Never stir test bath with bulb itself.** If possible, read test thermometer without removing it from bath and while continually stirring.

6th. Quickly compare chart or scale reading with that of test thermometer. If error is negligible and only a point check is desired, the checking procedure can end here.

If error is considerable, proceed as below.

7th. Turn point adjustment screw (11) until pen (17) actually records same temperature as test thermometer. Recheck readings carefully. This completes the point calibration. Thermometer now coincides with test thermometer at this single point.

If it is desired that thermometer read correctly thru its whole range, proceed as below.

Mechanical Alignment. This step should be necessary only if link length adjustment (12) or adjustments of lever (10) or hub (22) have been disturbed. Mechanical alignment adjustment places all links and levers in correct geometrical relation so as to minimize angularity errors.

1st. Place bulb in test bath of temperature to hold pen or pointer at about mid chart or scale. Hold this temperature thru step 4 below.

2nd. Loosen hub screw (21) and two link screws (12). Center the point adjuster (11).

3rd. While manually holding pen or pointer at mid scale, adjust length of (14) so that imaginary line "A-A" connecting center line of element shaft and link bearing (26) is parallel to lever (10).

4th. While holding this parallelism, tighten screws (12) and hub screw (21) firmly.

Step II Span Check and Calibration. It will be necessary to remove the chart plate and chart to reach the span adjustment.

Screwing span adjustment nut (28) back and forth changes effective length of threaded lever (29). Increasing lever length increases span thru which pen travels for a given temperature change. Decreasing lever length decreases span thru which pen travels for a given temperature change.

Proceed as follows:

1st. Carefully perform point calibration as in Step I above.

2nd. Immerse bulb & test thermometer in cold test bath, stir and compare readings as directed above.

3rd. If span is too long (thermometer reads low) loosen span lock screw (27) and reduce span by turning span adjustment nut (28) slightly toward shaft end of threaded lever. If span is too short (thermometer reads high) turn nut toward outer end of threaded lever.

4th. Recheck in hot bath and adjust with point adjustment (11) on pen arm.

5th. Recheck in cold bath and adjust span, if necessary.

6th. Alternately repeat point and span adjustments until thermometer is exactly correct in both hot and cold baths. Retighten span lock screw (27) firmly. Thermometer should then coincide with test thermometer at all values of its range.

IMPORTANT - ON CONTROLLING THERMOMETERS, With either electric or air control, controller set point indexes must always be adjusted after pen or pointer point adjustment (11) is changed. See instructions for Controlling System for details of calibration of set point indexes.

To avoid inconvenience of repeated removal and replacement of recorder chart and chart plate between each test reading, prepare a cut away chart from thermometer

-continued-

ing calibrated as per figure 23. Paste on stiff cardboard for support. During libration remove chart plate & use this it away chart held by chart hub.

Calibrating Temperatures. If only a int check and calibration is made, it obviously wise to select a test bath mperature close to the working range thermometer.

a span calibration is to be made, lect "cold" and "hot" test bath temp-atures at approximately 20% and 80% of e full range of thermometer being sted.

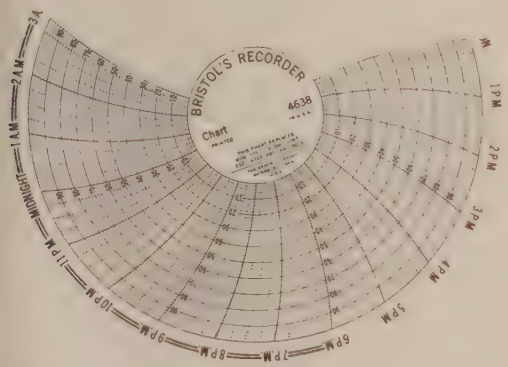


Fig. No. 23. Cut Away Chart for Use in Calibration.

. REPLACEABLE THERMOMETER SYSTEMS- l Bristol s pressure type thermom-ter systems are so made that entire mperature system can be exchanged replaced in the field without disturb-g its calibration. New, factory cal-rated thermometer systems can be ord-red from Bristol at any time. Factory de replacement systems are calibrated d tested in a standard recording therm-eter, then removed without disturbing libration, packed and shipped. ready or easy installation in the field.

Changing Ranges. An important fea-re of Bristol s thermometers is that ermometer systems of any range or any lass can be interchanged without dril-ng or extra parts. Or, a thermometer n be changed to a gauge by installing pressure gauge system.

Standby Thermometer Systems. Users aving several Bristol's Thermometers ill do well to stock one or two calibra-ed thermometer systems of each range sed, for quick replacement in case of mage to, or failure of a system, Stand-y thermometer systems should be ordered ith tubing long enough for any existing nstallation, and equipped with Bristol's niversal Bulb for ready adaptation to lmost any bulb installation.

3. How to Remove Thermometer System. Systems to be exchanged, repaired or replaced should be removed as follows:

1st. Remove bulb from process.

2nd. Dismount tubing, coil and tie it, being careful not to cut, twist or kink it.

3rd. Remove case fitting (16) which holds tubing, from the split connecting plate. **Do not allow weight of coil of tubing to hang by the delicate capillary (18).**

4th. Disconnect lower end of link (14) from span adjuster (27) by lifting and swinging aside tab (26). Do not loosen screw (27) or disconnect top bearing of link (14) from lever (10).

Note: There are several bearing holes in pen shaft lever (10).. All holes but one are painted black. Your thermometer was factory calibrated using unpainted hole. **use no other**

5th. Dismount bracket (20) by removing 2 screws (25)which hold it to back of case.

6th. Remove entire thermometer system as a **unit** including element, element mounting, span adjuster, tubing, case connection fitting and bulb.

4. How to Install Replacement Thermometer Systems.

1st. Carefully unpack replacement system. **Do not disturb any of its adjustments.**

2nd. Install element, & tubing in reverse order to instructions given in section 3 above.

3rd. When completely installed except the bulb, perform a point check at working temperature as instructed in Section 2, Step I, above. If span adjuster and connecting link have not been disturbed, the thermometer should be in perfect calibration.

Note: when thermometer systems from 8" size and 12" size instruments are interchanged, a complete recalibration is required due to the difference in pen arm radii, and pen weight.

5. How to Order Replacement Thermometer Systems. Order from nearest Branch Office, giving serial and chart number of your thermometer as listed on name-plate inside door. If ordering a system not exactly like your existing one, be sure to specify new range and new chart number desired, or new bulb number, union or socket thread size and length of tubing. If changing range, don't forget to order a stock of the new charts.

-over-

C. FACTORY REPAIR OF THERMOMETERS. Send all instruments or parts for repair or exchange **only to Branch or Main Factories,** whichever is nearest. **Do not send shipments to Branch Offices.** Send orders for repair to nearest Branch Office. See last page of this book for Addresses of Bristols Field Organization

If you have facilities for thermometer calibration, send only the thermometer system. If you do not have calibrating facilities, it is best to return the whole thermometer.

D. LUBRICATION AND CLEANING. Never lubricate any bearing in thermometer measuring system. If bearings become gummy or dirty, clean with carbon tetrachloride applied with a small, soft brush. If bearings become badly corroded, polish gently with crocus cloth. **Never use a file or emery.**

For lubrication & repair of chart drives, see Recording System Service - Front Index Page.

E. CORRESPONDENCE REGARDING THERMOMETERS, PARTS & SUPPLIES. Send all correspondence and orders to nearest Branch Office. Send all parts and thermometers for repair or exchange **only to Branch or Main Factories-not to Branch Offices.**

See last page of this book for addresses of Bristols Field Organization. Identify your shipments fully, including exact return address, your order number, etc.

BE SURE TO STATE MODEL AND SERIAL NUMBER OF THERMOMETERS IN ALL ORDERS, CORRESPONDENCE AND SHIPMENTS.

Printed in U.S.A.

HE BRISTOL COMPANY
ATERBURY 20, CONN., U. S. A.

PARTS LIST
Issue No. 2 of 6/50

T8005

PARTS LIST FOR CONVERTIBLE THERMOMETER BULB FITTINGS

E SURE TO STATE MODEL & SERIAL NUMBER OF INSTRUMENT WHEN ORDERING PARTS

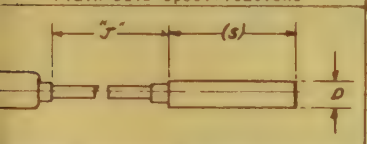
COMPLETE UNIONS AND SOCKETS

W TO ORDER UNIONS & SOCKETS

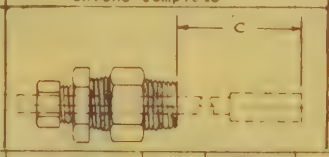
t. Select specification of bulb you have (as listed on your thermometer name plate) from Column I.
d. Follow to the right along horizontal line column II listing complete union or column III listing complete socket.
d. Order complete union by part no. as listed in Column II.
h. Order complete socket by part no and length "C" as listed in Column III.

otes:
1. The bulb itself cannot be purchased separately, but only as part of a complete thermometer system.
2. Union and socket parts must be large enough to slip over sensitive portion "S" of bulb. Therefore, always go from bulb specification number horizontally or down in table to union or socket number.
3. Class I sensitive bulb length "S" varies with range so cannot be listed. However "S" length will be listed as last number of bulb specification on your thermometer's nameplate.
4. Minimum socket length "C" should be ordered long enough to accommodate sensitive portion "S" plus "J" immersion of 3 inches, if possible, and never less than 1 inch, to minimize conductivity errors. See "Thermometer Measuring System" instructions for explanation.

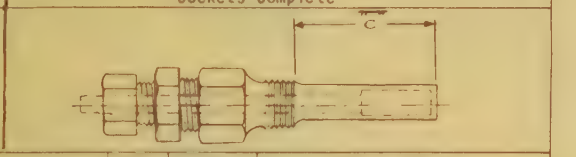
Column I
Plain Bulb Specifications



Column II
Unions Complete



Column III
Sockets Complete



LB SPECIFICATION (FROM NAMEPLATE)	METAL	"D" INCHES	"J" INCHES	"S" INCHES	METAL	STD PIPE THREAD INCHES	PART NO. OF COMPLETE UNION	METAL	STD PIPE THREAD INCHES	PART NO. OF COMPLETE SOCKET	STANDARD LENGTH "C" UNDER THREAD INCHES
					CLASS I THERMOMETER BULBS						
013-10-( )	Copper	3/8	10	(See Note 3 above)	brass	1/2	82920	bronze	1/2	84424	Minimum Socket length "C" is determined by sensitive length "S" plus minimum immersion of neck "J" (see note 4) Standard Class I socket lengths are: 2½"-3½" 5½"-7½" 12"-18" 24"-30"
013-30-( )	Copper	3/8	30		brass	1/2	82920	bronze	1/2	84424	
013-60-( )	Copper	3/8	60		brass	1/2	82920	bronze	1/2	84424	
023-10-( )	Stain S.	3/8	10		Stain. S.	1/2	82921	Welded S.S.	1/2	84425	
023-30-( )	Stain.S.	3/8	30		Stain. S.	1/2	82921	Welded S.S.	1/2	84425	
023-60-( )	Stain.S.	3/8	60		Stain. S.	1/2	82921	Welded S.S.	1/2	84425	
015-10-( )	Copper	5/8	10		brass	3/4	82923	bronze	3/4	84426	
015-30-( )	Copper	5/8	30		brass	3/4	82923	bronze	3/4	84426	
015-60-( )	Copper	5/8	60		brass	3/4	82923	bronze	3/4	84426	
025-10-( )	Stain.S.	5/8	10		Stain. S.	3/4	84550	Welded S.S.	3/4	84427	
025-30-( )	Stain.S.	5/8	30		Stain. S.	3/4	84550	Welded S.S.	3/4	84427	
025-60-( )	Stain.S.	5/8	60		Stain. S.	3/4	84550	Welded S.S.	3/4	84427	
034-10-( )	lead protected	1/2	10		brass or	3/4	82923				
034-30-( )		1/2	30								
034-60-( )	copper	1/2	60		Stain. S.	3/4	84550				
016-10-( )	coil bulbs	3/4	10		brass	1	84551				
016-30-( )		3/4	30		brass	1	84551				
016-60-( )	copper	3/4	60		brass	1	84551				
026-10-( )	coil bulb	3/4	10		Stain. S.	1	84552				
026-30-( )		3/4	30		Stain. S.	1	84552				
026-60-( )	Stain.S.	3/4	60		Stain. S.	1	84552				
					CLASS II THERMOMETER BULBS						
013-10-040	copper	3/8	10	4	brass	1/2	82920	bronze	1/2	84424	5½-7½
013-30-040	copper	3/8	30	4	brass	1/2	82920	bronze	1/2	84424	5½-7½-12-18-24
013-60-040	copper	3/8	60	4	brass	1/2	82920	bronze	1/2	84424	5½-7½-12-18-24-30
023-10-040	Stain.S.	3/8	10	4	Stain. S.	1/2	82921	Welded S.S.	1/2	84425	5½-7½
023-30-040	Stain.S.	3/8	30	4	Stain. S.	1/2	82921	Welded S.S.	1/2	84425	5½-7½-12-18-24
023-60-040	Stain.S.	3/8	60	4	Stain. S.	1/2	82921	Welded S.S.	1/2	84425	5½-7½-12-18-24-30
015-10-017	copper	5/8	10	1.75	brass	3/4	82923	bronze	3/4	84426	2½-3½-5½
015-30-017	copper	5/8	30	1.75	brass	3/4	82923	bronze	3/4	84426	2½-3½-5½-7½-12-18-24
015-60-017	copper	5/8	60	1.75	brass	3/4	82923	bronze	3/4	84426	2½-3½-5½-7½-12-18-24-30
025-10-017	Stain.S.	5/8	10	1.75	Stain. S.	3/4	84550	Welded S.S.	3/4	84427	2½-3½-5½
025-30-017	Stain.S.	5/8	30	1.75	Stain. S.	3/4	84550	Welded S.S.	3/4	84427	2½-3½-5½-7½-12-18-24
025-60-017	Stain.S.	5/8	60	1.75	Stain. S.	3/4	84550	Welded S.S.	3/4	84427	2½-3½-5½-7½-12-18-24-30
034-10-070	lead protected	1/2	10	7	brass or	3/4	82923				
034-30-070		1/2	30	7							
034-60-070	copper	1/2	60	7	Stain. S.	3/4	84550				
016-10-040	coil bulbs	3/4	10	4	brass	1	84551				
016-30-040		3/4	30	4	brass	1	84551				
016-60-040	copper	3/4	60	4	brass	1	84551				
016-10-040	coil bulbs	3/4	10	4	Stain. S.	1	84552				
016-30-040		3/4	30	4	Stain. S.	1	84552				
016-60-040	Stain.S.	3/4	60	4	Stain. S.	1	84552				
					CLASS III THERMOMETER BULBS						
016-10-100	copper	3/4	10	10	brass	1	84551	bronze	1	84429	10½-12
016-30-100	copper	3/4	30	10	brass	1	84551	bronze	1	84429	10½-12-18-24-30
016-60-100	copper	3/4	60	10	brass	1	84551	bronze	1	84429	10½-12-18-24-30
026-10-100	Stain.S.	3/4	10	10	Stain. S.	1	84552	Welded S.S.	1	84430	10½-12
026-30-100	Stain.S.	3/4	30	10	Stain. S.	1	84552	Welded S.S.	1	84430	10½-12-18-24-30
026-60-100	Stain.S.	3/4	60	10	Stain. S.	1	84552	Welded S.S.	1	84430	10½-12-18-24-30
018-10-050	copper	1	10	5	brass	1¼	84568	bronze	1¼	84431	5½-7½
018-30-050	copper	1	30	5	brass	1¼	84568	bronze	1¼	84431	5½-7½-12-18-24
018-60-050	copper	1	60	5	brass	1¼	84568	bronze	1¼	84431	5½-7½-12-18-24-30

-continued over-

THE BRISTOL COMPANY
WATERBURY 91, CONN., U.S.A.

PARTS LIST FOR CONVERTIBLE THERMOMETER BULB FITTINGS

continued from page 1

Part number - catalog item nameplate	Metal	"F" inches	"A" inches	"B" inches	Metal	STD. pipe thread inches	Part no. of complete union	Metal	STD. pipe thread inches	Part no. of complete socket	Standard length "C" under thread inches
3006-10-050	Stain. S.	1	10	5	Stain. S.	1¼	84569	Welded S.S.	1¼	84432	5½-7½
3006-30-050	Stain. S.		30	5	Stain. S.		84569	Welded S.S.	1¼	84432	5½-7½-12-18-24
3006-60-050	Stain. S.		60	5	Stain. S.		84569	Welded S.S.	1¼	84432	5½-7½-12-18-24-30
3.19-10-060	averlapping	3½	10	25 ft.	brass	1	84551	Extra heavy lapping sockets for high Pressure. Machined from steel forging. All fittings are brass.			
3.19-30-060	bulbs*	3½	30	25 ft.	brass	1	84551				
3.19-60-060	copper	3½	60	25 ft.	brass	1	84551				
3.29-10-060	overlapping	3½	10	25 ft.	Stain. S.		84552				
3.29-30-060	bulbs*	3½	30	25 ft.	Stain. S.		84552				
3.29-60-060	Stain. S.	3½	60	25 ft.	Stain. S.	1	84552				

Part number	Metal	"F" inches	"A" inches	"B" inches	Metal	STD. pipe thread inches	Part no. of complete union	Metal	STD. pipe thread inches	Part no. of complete socket	Standard length "C" under thread inches
3006-10-11	lead pro-	1	10	11	brass	1¼	84568	solid	1	86157	10½
3006-30-11	tected	1	30	11	or			steel	1¼	87926	5½
3006-60-11	copper	1	60	11	Stain. S.	1¼	84569				

*Union cannot slip on over whole bulb coil but must be slipped over the 25 ft. bulb tubing

UNION PARTS

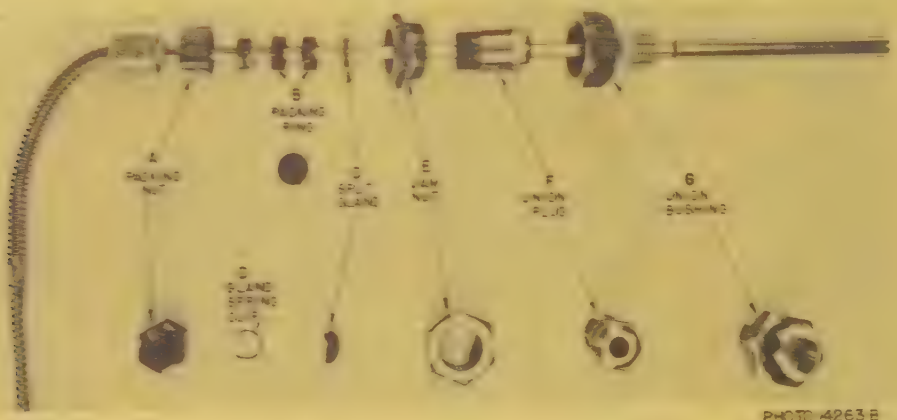
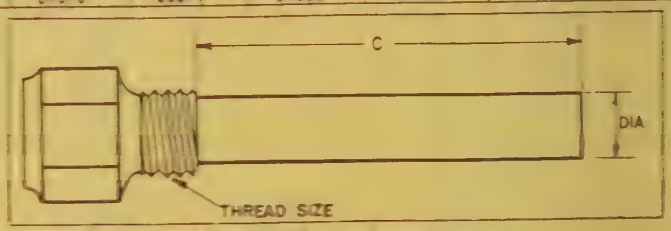


PHOTO 4263 B

For bulb size inches	STD. pipe thread size inches	Metal	A packing nut	B packing ring (2 required)	C split gland (4 required)	D gland spring clip (2 required)	E jam nut	F union plug	G union bushing	Part no. of complete union
3/8	1/2	brass	83903	84367	84014	86839	83921	83922	83920	82920
1/2 or 5/8	3/4	brass	83905	84368	84015	86840	83927	83928	83925	82928
3/4	1	brass	83909	84368	84016	86840	83907	83928	83926	84551
	1¼	brass	84484	84377	84375	86841	84456	84455	84457	84566
3/8	1/2	S.S.	83903	84367	84015	86839	83933	83932	83931	82921
1/2 or 5/8	3/4	S.S.	83906	84368	84017	86840	83937	83936	83935	84550
3/4	1	S.S.	83908	84368	84017	86840	83937	83936	83939	84552
	1¼	S.S.	84488	84377	84375	86841	84566	84459	84566	84569

Note: All sockets are exactly the same fittings as unions of the same thread size above, except that union bushing "G" is replaced by the socket.



SOCKETS ONLY

Be sure to specify part number and length "C" in ordering sockets

For bulb size inches	STD. pipe thread inches	Metal	Socket diam. B inches	Part no. socket only	Standard "C" lengths inches (see notes 2 & 4 page 2 on how to order)
3/8	1/2	bronze	1/2	84912	3½-5½-7½-12-18-24-30
1/2 & 5/8	3/4	bronze	3/4	84910	2½-3½-5½-7½-12-18-24-30
3/4	1	bronze	7/8	84914	10½-12-18-24-30
	1¼	bronze	1 5/32	84916	5½-7½-12-18-24-30
3/8	1/2	Stain. S.	1/2	84913	3½-5½-7½-12-18-24-30
1/2 & 5/8	3/4	Stain. S.	3/4	84911	2½-3½-5½-7½-12-18-24-30
3/4	1	Stain. S.	7/8	84915	10½-12-18-24-30
	1¼	Stain. S.	1 1/16	84917	5½-7½-12-18-24-30
3/8	3/4	Aluminum	7/8	85122	4 - 5 - 9

INSTRUCTION NO. H10010

(Issue No. 1 of 12/50)

INSTALLATION, OPERATION AND SERVICE OF BRISTOL'S WET- AND DRY-BULB RECORDING PSYCHROMETER USING FIXTURES 124, 176, 188 AND 197

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B. Locating and Mounting the Recorder	2
C. Locating and Mounting the Fixtures	2
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2. Fixture 176	2
3. Fixture 188	3
4. Fixture 197	3
D. Installing the Thermometer Tubing and Bulbs	3
E. Installing the Wet-bulb Wick	4
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PART IV SERVICE	4
A. Routine Maintenance	4
B. Non-routine Maintenance	4
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THE BRISTOL COMPANY WATERBURY 20, CONN.

Note: This instruction covers only the installation, operation and service of the psychrometer fixture. See separate instructions covering the recording, controlling system, etc., as required.

PART I GENERAL

Bristol's Wet- and Dry-Bulb Psychrometer using Fixtures 124, 176, 188 or 197 is an instrument for recording or controlling relative humidity. The entire measuring and recording system consists of a single two-pen recorder, two separate thermometer bulbs with tubing and measuring elements, and special fixture to provide a water supply for the wet bulb. Other fixtures are available to provide forced-air sampling where the normal circulation is not sufficient to get a representative sample. Separate instructions cover these fixtures.

Fixtures 124, 176, 188 and 197 are illustrated in this instruction.

PART II INSTALLATION

A. Unpacking the Instrument

The psychrometer comes with both bulbs permanently attached to the recorder. Be careful not to kink the tubing. Never move or handle the instrument case by the tubing.

Do not throw away the packing until you have found the mounting brackets, screws and other accessories, such as ink, charts, wicks, etc.

B. Locating and Mounting the Recorder

The psychrometer recorder should be mounted in a location as free as possible from dust, dirt, vibration, corrosive fumes and extremes of ambient temperature. Use a level on the instrument case to make sure that the instrument is exactly level.

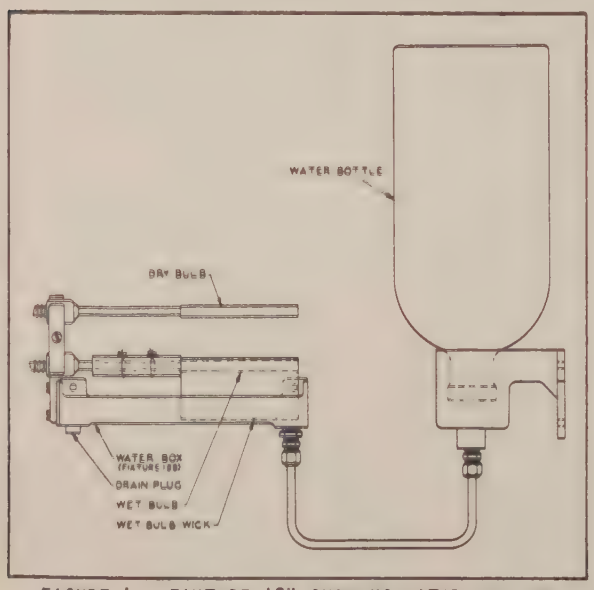

FIGURE 1. FIXTURE 124 SHOWING WATER BOX FOR CLASS I PSYCHROMETERS

C. Locating and Mounting the Fixtures

1. Fixture 124 (see Fig. 1). Mount Fixture 124 where the humidity is to be measured. The circulation of the air in the area of measurement should be as great as possible. If good circulation cannot be achieved, it may be necessary to go to forced-air sampling.

Attach the water box (reservoir) to a firm support. Then determine the correct position for the water bottle by filling it with water, inserting it in its holder and adjusting its height until the water level in the water box is about 3/16" from the top.

2. Fixture 176 (see Fig. 2). Mount Fixture 176 where the humidity is to be measured. The circulation of the air in the area of measurement should be as great as possible. If good circulation cannot be achieved, it may be necessary to go to forced-air sampling.

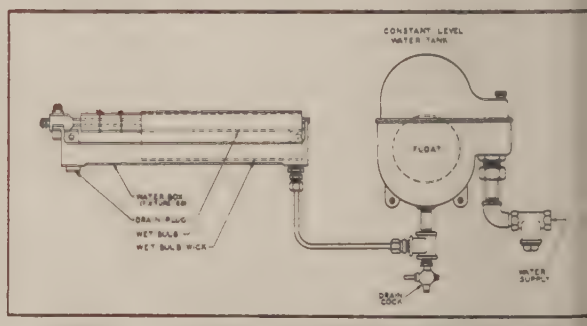

FIGURE 2. FIXTURE 176 SHOWING WATER BOX FOR CLASS II AND III PSYCHROMETER

Attach the water box and float tank to a firm support (Note: One mounting-screw hole is located inside the tank; take off the cover). Connect a water supply to the

T as shown so that the water flows in the direction indicated by the arrow. Turn on the water to the float tank. The water box should fill up to within 3/16" from the top before the float tank automatically shuts off. To adjust the shut-off level, remove the cover from the float tank and turn the adjusting screw on the valve lever arm. Test for the correct shut-off level by draining the water box (by means of the petcock) and allowing it to fill up again.

3. Fixture 188 (see Fig. 3). Mount Fixture 188 where the humidity is to be measured. The circulation of the air in the area of measurement should be as great as possible. If good circulation cannot be achieved, it may be necessary to go to forced-air sampling.

Fixture 188 requires a manually regulated water supply which is brought in thru a hole in the bottom of the water box. A drain pipe is also required. This must be connected to the hole which has the drain boss. It is recommended that a needle valve be used for regulating the flow. Adjust the rate of flow so that the water box overflows continuously at a minimum rate.

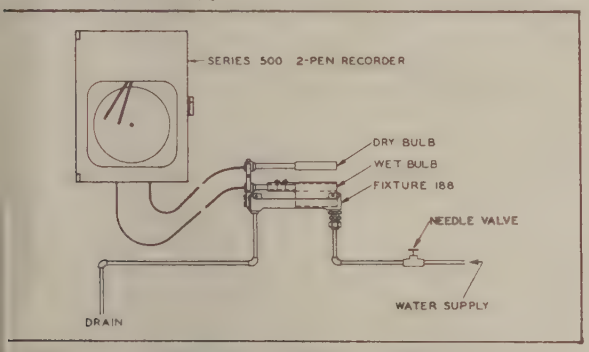

FIGURE 3. FIXTURE 188 SHOWING A COMPLETE CLASS I PSYCHROMETER INSTALLATION

4. Fixture 197 (see Fig. 4). Mount Fixture 197 where the humidity is to be measured. The circulation of the air in the area of measurement should be as great as possible. If good circulation cannot be achieved, it may be necessary to go to forced-air sampling. The wet bulb in Fixture 197 takes a porous alundum sleeve instead of a wick. This sleeve is kept wet by a constant-level tank. Installation of the bulb and sleeve is covered in paragraph D below.

Attach the bulb mounting bracket and float tank to a firm support (Note: One mounting-screw hole is located inside the tank; take off the cover). Connect a water supply to the T as shown so that the water flows in the direction indicated by the arrow. Turn on the water to the float tank. The alundum sleeve and wet bulb must be in the fixture to check the water level (see paragraph below for installation instructions). The water level maintained by the float tank should be just high enough to keep the sleeve wet but not high enough to allow water to run out of the overflow hole in the top of the alundum sleeve. To adjust the shut-off level, remove the cover from the float tank and turn the adjusting screw on the valve lever arm. Test for the correct shut-off level by draining the water from the sleeve (by means of the petcock) and allowing it to fill up again.

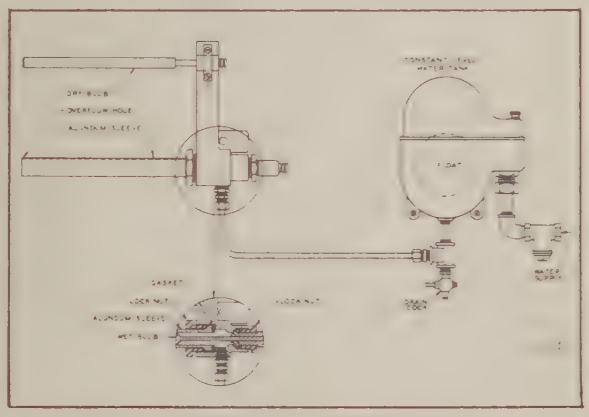

FIGURE 4. FIXTURE 197

D. Installing the Thermometer Tubing and Bulb

1. Tubing. The installation and protection of thermometer tubing are covered in separate instructions included with each psychrometer.

2. Bulbs. The dry bulb is identified by red markings and its temperature is recorded by the red pen. The wet bulb has blue markings and its temperature is recorded by the blue pen.

In Fixtures 124, 176 and 188, class I wet and dry bulbs are mounted vertically (one above the other) on a bracket as shown in Fig. 1. Class II or III wet and dry bulbs are mounted horizontally (side by side) as shown in Fig. 2. Remove the bulb clamp, insert the bulbs and clamp them securely to the mounting bracket.

In Fixture 197 the dry bulb is clamped to the top of the bracket as shown in Fig. 4. The wet bulb is mounted as shown in the cross-sectional view in Fig. 4. Be sure that the overflow hole in the alundum sleeve is at the top of the sleeve.

E. Installing the Wet-bulb Wick

Three linen or cotton wicks are provided for the wet bulb. No other type of wick should be used. One is installed on the bulb, one should be kept in pure water for quick replacement, and one is kept as a spare.

Slide the wick onto the wet bulb with the flap towards the neck of the bulb. The wick must cover the entire sensitive portion of the bulb, and the flap must be wound around the neck of the bulb and fastened securely with thread or string. The main section of the wick, of course, must hang into the water box and be well into the water at all times.

F. Checking the Installation

Before putting your psychrometer int permanent operation, check the followin items:

1. The recorder chart drive must b turned on.
2. The recorder pens must be fille with the proper color ink and shoul trace a clean, legible record
3. The water supply must be turned on
4. The wick must be clean and tho roughly wet.
5. The circulation of air at the bulb should be as great as possible. I is generally considered advisabl to have air moving at a velocity c 15 ft./sec. over the bulbs to obtai the most accurate readings.

PART III OPERATION

To operate the Bristol Wet- and Dry-Bulb Pyschrometer after it has been completely and correctly installed, it is only necessary to turn on the recorder chart drive. To determine the relative humidity of the atmosphere under measurement, refer to the Relative Humidity Table included with this instruction. Read the difference between the two pen records anywhere on the chart where the humidit is desired. Also read the dry-bulb temp erature at the same spot. The relativ humidity is indicated on the table wher the dry-bulb temperature and the dif ference between the wet- and dry-bul readings intersect. This table is cal culated for normal atmospheric pressure

PART IV SERVICE

A. Routine Maintenance

The Bristol Psychrometer will give many years of accurate and continuous service if a few simple routine-service procedures are followed:

1. The water box should never be allowed to become empty. Keep it filled with pure water.

2. Clean the thermometer bulbs as often as experience shows it to be necessary. A film of dirt or dust can cause inaccuracies.

3. Change the wet-bulb wick often. It is suggested that one of the spare wicks be kept in pure water ready for immediate installation while the old wick is taken out of service for cleaning. Wash the used wick in a mild solvent (like soap and water) to get rid of mineral deposits and dirt that may have been in the water supply.

B. Non-routine Maintenance

The service section of the standard thermometer instructions furnished with the psychrometer covers the non-routin maintenance problems associated wit thermometer systems.

When checking your wet- and dry-bul psychrometer against a standard (hygro meter or sling psychrometer), be sure tha the test measurements are taken at th location of the wet and dry bulbs.

C. Repairs, Correspondence and Shippin

If the psychrometer cannot be repaire with the information furnished, it shoul be shipped to the nearest Bristol Compan Branch Factory or Main Factory at Water bury for repair or replacement. Do no ship instruments to Branch Offices. B sure to mark your return address plainl

In all correspondence please mentio the instrument model and serial numbe (as listed on its nameplate) and you repair order number. Address all cor respondence to the Bristol Company Branc or Main Offices, a list of which is foun in this instruction manual.

Printed in U.S.

RELATIVE HUMIDITY TABLE

DRY BULB READING F	DIFFERENCE BETWEEN WET AND DRY BULB READINGS DEG. FAHR. PRESSURE 30."																																																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
35	91	81	72	63	54	45	36	27	19	10	2																																						
36	91	82	73	64	55	46	38	29	21	13	5																																						
37	91	83	74	65	57	48	40	31	23	15	7																																						
38	91	83	75	66	58	50	42	34	25	17	10	2																																					
39	92	83	75	67	59	51	43	35	27	20	12	5																																					
40	92	83	75	68	60	52	45	37	29	22	15	7	0																																				
41	92	84	76	69	61	54	46	39	31	24	17	10	3																																				
42	92	85	77	69	62	55	47	40	33	26	19	12	5																																				
43	92	85	77	70	63	55	48	42	35	28	21	14	8	1																																			
44	93	85	78	71	63	56	49	43	36	30	23	16	10	4																																			
45	93	86	78	71	64	57	51	44	38	31	25	18	12	6																																			
46	93	86	79	72	65	58	52	45	39	32	26	20	14	8	2																																		
47	93	86	79	72	66	59	53	46	40	34	28	22	16	10	5																																		
48	93	86	79	73	66	60	54	47	41	35	29	23	18	12	7	1																																	
49	93	86	80	73	67	61	54	48	42	36	31	25	19	14	9	3																																	
50	93	87	80	74	67	61	55	49	43	38	32	27	21	16	10	5	0																																
51	94	87	81	75	68	62	56	50	45	39	34	28	23	17	12	7	2																																
52	94	87	81	75	69	63	57	51	46	40	35	29	24	19	14	9	4																																
53	94	87	81	75	69	63	58	52	47	41	36	31	26	20	16	10	6	1																															
54	94	88	82	76	70	64	59	53	48	42	37	32	27	22	17	12	8	3																															
55	94	88	82	76	70	65	59	54	49	43	38	33	28	23	19	14	9	5	0																														
56	94	88	82	76	71	65	60	55	50	44	39	34	30	25	20	16	11	7	2																														
57	94	88	82	77	71	66	61	55	50	45	40	35	31	26	22	17	13	8	4																														
58	94	88	83	77	72	66	61	56	51	46	41	37	32	27	23	18	14	10	6	1																													
59	94	89	83	78	72	67	62	57	52	47	42	38	33	29	24	20	16	11	7	3																													
60	94	89	83	78	73	68	63	58	53	48	43	39	34	30	26	21	17	13	9	5	1																												
61	94	89	84	78	73	68	63	58	54	49	44	40	35	31	27	22	18	14	10	7	3																												
62	94	89	84	79	74	69	64	59	54	50	45	41	36	32	28	24	20	16	12	8	4	1																											
63	95	89	84	79	74	69	64	60	55	50	46	42	37	33	29	25	21	17	13	10	6	2																											
64	95	90	84	79	74	70	65	60	56	51	47	43	38	34	30	26	22	18	15	11	7	4																											
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73	95	91	86	82	78	73	69	65	61	57	53	50	46	42	39	35	32	29	25	22	19	16	13	10	7	4	1																						
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77	96	91	87	83	79	74	71	67	63	59	56	52	48	45	42	39	35	32	29	26	23	20	17	14	12	9	6	4																					
78	96	91	87	83	79	75	71	67	63	60	56	53	49	46	43	39	36	33	30	27	24	21	18	16	13	10	8	5																					
79	96	91	87	83	79	75	71	68	64	60	57	53	50	46	43	40	37	34	31	28	25	22	19	17	14	11	9	6																					
80	96	91	87	83	79	75	72	68	64	61	57	54	50	47	44	41	38	35	32	29	26	23	20	18	15	12	10	7																					
81	96	91	87	83	79	75	72	68	64	61	57	54	50	47	44	41	38	35	32	29	27	24	21	19	16	13	11	8																					
82	96	92	88	84	80	76	72	69	65	61	58	55	51	48	45	42	39	36	33	30	28	25	22	20	17	14	12	10	7	5	2																		
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200	98	96	94	92	90	88	86	84	82	81	79	77	75	74	72	70	69	67	66	64	63	61	60	58	57	55	54	53	52	51	49	48	47	46	45	43	42	41	40	39	38	37	36	35	34				
205	98	96	94	92	90	88	86	84	83	81	79	77	76	74	72	71	69	68	66	65	63	62	60	59	57	56	55	54	53	51	50	49	48	46	45	44	43	42	41	40	39	38	37	36	35				
210	98	96	94	93	90	88	87	85	83	81	80	78	76	75	73	71	70	68	67	65	63	62	61	60	58	57	56	54	53	52	51	49	48	47	46	45	44	43	42	41	40	39	38	37	36				

R CENT RELATIVE HUMIDITY. Take the readings of the WET BULB and the DRY BULB at any particular time. e difference between the two readings is the WET BULB DEPRESSION. Run down the column headed by this fference to the intersection with the DRY BULB Temperature. This gives the per cent Relative Humidity.

FOR EXAMPLE: DRY BULB TEMPERATURE ..... 71° DIFFERENCE .....15 deg.
WET BULB TEMPERATURE ..... 56° RELATIVE HUMIDITY .....37 %

-see over for Centegrade Table-

THE BRISTOL COMPANY
Waterbury 91, Conn., U.S.A.

PERCENT RELATIVE HUMIDITY FOR DRY BULB TEMPERATURES OF 0 TO 100°C

PHOTO NO 12786

WET BULB DEPRESSION PSYCHROMETRIC DIFFERENCE (DEGREES C.) PRESSURE: 760 mm

DRY BULB TEMP. °C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
0	82	64	47	31	14																																								
1	83	66	50	34	18	3																																							
2	84	68	52	37	22	8																																							
3	84	69	54	40	25	12																																							
4	85	70	56	42	29	16	3																																						
5	86	72	58	45	32	19	7																																						
6	86	73	60	47	35	23	11																																						
7	87	75	61	49	37	26	14	3																																					
8	87	75	62	51	40	29	18	7																																					
9	88	76	64	53	42	31	21	11																																					
10	88	77	65	55	44	34	24	14	5																																				
11	88	77	66	56	46	36	26	17	8																																				
12	89	78	68	57	48	38	29	20	11	3																																			
13	89	79	69	59	49	40	31	23	14	6																																			
14	90	79	70	60	51	42	33	25	17	9	2																																		
15	90	80	71	61	53	44	35	27	20	12	5																																		
16	90	81	71	62	54	46	37	30	22	15	8	1																																	
17	90	81	72	63	55	47	39	32	24	17	10	4																																	
18	91	82	73	65	56	49	41	34	27	20	13	6																																	
19	91	82	74	65	58	50	43	36	29	22	15	9	3																																
20	91	83	74	66	59	51	44	37	31	24	18	12	6																																
21	91	83	75	67	60	52	45	39	32	26	20	14	8	3																															
22	92	83	75	68	61	54	47	40	34	28	22	16	11	5																															
23	92	84	76	69	62	55	48	42	36	30	24	18	13	8	3																														
24	92	84	77	70	62	56	49	43	37	31	26	20	15	10	5																														
25	92	85	77	70	63	57	51	44	39	33	27	22	17	12	7	3																													
26	92	85	78	71	64	58	51	45	40	34	29	24	19	14	9	5																													
27	93	85	78	71	65	59	53	47	41	36	31	25	21	16	11	7	3																												
28	93	86	79	72	65	59	53	48	42	37	32	27	22	18	13	9	5																												
29	93	86	79	72	66	60	54	49	43	38	33	28	24	19	15	11	7	3																											
30	93	86	79	73	67	61	55	50	44	39	34	30	25	21	17	13	9	5																											
31	93	86	80	73	67	61	56	51	45	41	36	31	27	22	18	14	10	7	3																										
32	93	87	80	74	68	62	57	52	46	42	37	32	28	24	20	16	12	8	5																										
33	93	87	80	74	69	63	58	52	47	43	38	34	29	25	21	17	14	10	7	3																									
34	93	87	81	75	69	63	58	53	48	44	39	35	30	26	22	19	15	12	8	5	2																								
35	93	87	81	75	70	64	59	54	49	44	40	36	32	28	24	20	17	13	10	7	4																								
36	93	87	81	76	70	65	59	55	50	45	41	37	33	29	25	21	18	15	11	8	5	2																							
37	94	87	82	76	71	65	60	55	51	46	42	38	34	30	26	23	19	16	13	10	7	4	1																						
38	94	88	82	76	71	66	61	56	51	47	43	39	34	31	27	24	20	17	14	11	8	5	2																						
39	94	88	82	77	71	66	61	57	52	48	44	40	35	32	28	25	21	18	15	12	10	7	4	2																					
40	94	88	83	77	72	67	62	57	53	49	44	40	35	32	28	26	23	19	17	14	11	9	6	3																					
42	94	88	83	77	72	67	62	57	53	49	45	41	37	33	30	28	25	22	19	16	13	11	8	5	3																				
44	94	88	83	77	72	67	63	58	54	50	46	42	39	35	32	30	27	24	21	18	16	14	11	8	5	2																			
46	94	88	83	78	73	68	64	59	55	51	47	43	40	37	33	31	28	26	23	20	17	16	12	10	8	5	4	2																	
48	94	89	83	78	74	69	65	60	56	52	48	45	41	38	35	33	30	28	25	22	19	17	14	12	10	8	6	4	2																
50	94	89	84	79	74	70	66	61	57	53	50	46	43	40	36	34	32	29	27	24	21	19	17	14	12	10	8	6	4	3															
52	94	89	84	79	75	70	66	62	58	54	51	48	44	41	38	36	33	30	28	25	23	21	18	16	14	12	10	8	6	5	3	2													
54	95	90	85	80	76	71	67	63	59	55	52	49	46	42	39	38	34	32	29	26	24	22	20	17	16	13	11	9	8	7	5	4	2												
56	95	90	85	80	76	72	68	64	60	56	53	50	47	43	40	38	36	33	30	27	26	24	22	19	17	15	13	11	10	8	7	5	4	3											
58	95	90	85	81	77	72	68	64	61	57	54	51	48	44	41	39	36	34	31	29	26	24	22	20	19	17	14	13	11	10	8	6	5	4	3										
60	95	90	86	81	77	73	69	65	61	58	55	51	48	45	43	40	37	35	32	30	28	25	23	21	20	18	16	14	13	11	10	8	6	5	4	3	2								
62	95	90	86	82	78	74	70	66	62	59	56	52	49	46	44	41	38	36	33	31	29	27	25	23	21	19	17	15	14	13	11	9	8	7	5	4	3	2							
64	95	91	86	82	78	74	70	67	63	60	57	53	50	47	45	42	39	37	34	32	30	28	26	24	22	20	18	16	15	14	12	11	9	8	7	5	4	3	2	2					
66	95	91	87	83	79	75	71	67	64	61	57	54	51	48	46	43	40	37	35	33	31	29	27	25	23	21	19	17	16	15	13	12	11	10	8	7	6	5	3	3	3				
68	95	91	87	83	79	75	72	68	64	61	58	55	52	49	47	44	41	38	36	34	32	30	28	26	24	22	20	19	17	16	14	13	12	11	10	8	7	6	4	4	4				
70	95	91	87	83	79	76	72	69	65	62	59	56	53	50	48	45	42	39	37	35	33	31	29	27	25	24	22	20	19	17	16	14	13	12	11	9	8	7	6	6	5	4	3		
72	95	91	87	84	80	76	73	69	66	63	59	56	53	51	48	45	43	40	38	36	34	32	30	28	26	25	23	21	19	18	17	15	14	13	12	10	9	8	7	6	6	5	4	2	
74	96	91	87	84	80	76	73	70	66	63	60	57	54	52	49	46	44	41	39	37	35	33	31	29	27	26	24	22	20	19	18	16	15	14	12	11	10	9	8	7	7	6	5	3	
76	96	92	88	84	80	77	73	70	67	64	61	58	55	52	50	47	44	42	40	38	36	34	32	30	28	26	24	23	21	20	19	17	16	15	13	12	11	10	9	8	8	7	6	4	
78	96	92	88	84	81	77	74	71	67	64	61	58	56	53	51	48	46	43	41	39	37	35	33	31	29	27	25	24	22	21	20	18	17	16	14	13	12	11	10	9	8	8	7	5	3
80	96	92	88	84	81	78	74	71	68	65	62	59	56	54	51	49	46	44	42	40	38	36	33	31	30	28	26	25	23	22	20	19	18	17	15	14	14	13	11	10	8	8	7	6	4
82	96	92	88	85	81	78	75	71	68	65	62	59	57	54	52	49	47	44	42	40	38	36	34	32	31	29	27	25	24	23	21	20	19	18	16	15	14	13	12	11	10	8	8	7	5
84	96	92	88	85	82	78	75	72	69	66	63	60	57	55	53	50	48	45	43	41	39	37	35	33	32	30	28	26	24	23	22	21	19	18	17	15	14	14	13	12	11	10	9	8	6
86	96	92	89	85	82	78	75	72	69	66	63	61	58	55	53	50	48	46	43	41	39	37	36	34	32	30	28	27	26	24	23	21	20	19	18	16	15	14	13	12	11	11	10	9	7
88	96	92	89	85	82	79	76	72	69	67	64	61	58	56	54	51	49	46	44	42	40	38	36	34	33	31	29	28	26	25	23	22	21	20	18	17	16	15	14	13	12	12	11	10	8
90	96	92	89	86	82	79	76	73	70	67	64	62	59	56	54	52	49	47	45	43	41	39	37	35	34	32	30	28	27	26	24	23	22	20	19	18	17	16	15	14	13	12	11	10	9
92	96	93	89	86	83	79	76	73	70	67	65	62	59	57	54	52	50	48	45	43	41	39	38	36	34	32	31	29	28	27	25	24	22	21	20	19	18	16	15	14	13	12	11	10	10
94	96	93	89	86	83	79	76	73	70	68	65	62	60	57	55	52	50	48	46	44	42	40	38	36	35	33	31	30	28	27	26	24	23	22	21	19	18	17	16	15	14	13	12	11	10
96	96	93	89	86	83	79	76	73	71	68	65	63	60	58	55	53	51	48	46	44	42	40	39	37	36	34	32	30	29	28	26	25	24	22	21	20	19	18	17	16	15	14	13	12	11
98	96	93	89	86	83	80	77	74	71	68	66	63	60	58	55	53	51	49	47	45	43	41	39	38	36	34	33	31	30	29	27	26	24	23	22	21	20	19	18	17	16	15	14	13	12
100	96	93	89	86	83	80	77	74	71	69	66	63	61	59	56	54	52	50	48	46	44	42	40	38	36	35	33	32	30	29	28	26	25	24	23	22	20	19	18	17	16	15	14	13	13
DRY BULB TEMP °C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45

Data from H. [illegible] Feuchtigkeitsmessung, Berlin, [illegible]
[illegible] Bul. No. [illegible], Washington, [illegible]
[illegible] Science and Industrial Research
Report No. [illegible], London, [illegible]

Take the readings of both Wet Bulb and Dry Bulb-temperatures at any particular time. The difference between these two readings is the "Wet Bulb Depression".

Run down the column headed with this difference to the horizontal line of the Dry Bulb Temperature. The figure at the intersection is the Per cent Relative Humidity.

For example:

Dry Bulb temperature	[illegible]
Wet Bulb temperature	[illegible]
Differential ...	[illegible] deg
Relative Humidity	[illegible]

-see over for Fahrenheit Table-

Instruction W-18220
Issued February 1951

HOW TO ORDER PARTS AND SUPPLIES

FOR BRISTOL PRODUCTS

In all correspondence concerning any product of the Bristol Company, always give the model and serial number of the product concerned. Send your purchase order or quotation request to the nearest Bristol Company Branch Office (see the back of this sheet for addresses).

REPLACEMENT PARTS

When ordering replacement parts look up the part name and number in the parts list provided with the instructions that came with your product. When you cannot find a part number, give an accurate description of the part. If you have mislaid your parts list write for a new one giving the model and serial number of the product.

CHARTS

In ordering charts for recorders, give the chart number (printed on the chart and also on the instrument name plate).

Avoid inconvenient emergency orders by keeping a six months supply of charts on hand for each of your recorders.

THERMOCOUPLES

Pyrometer thermocouples should be ordered from Bulletin P-1238. Be sure to specify the catalog number and the length. If you do not have Bulletin P-1238, write for one.

Pyrometer users should always have a supply of spare thermocouples.

SAMPLE PURCHASE ORDER:

QUANTITY REQUIRED	DESCRIPTION	PART, CHART OR CATALOG NUMBER
1000	Charts, 0° to 1500°F	5342
5	7-day electric chart drive for 115 volts, 60 cycles	86226
4	Pen arms marked CD	49703
1	Knurled plastic knob on outside of case, ½" diameter, 3/16" hole for moving set-point index	none given
1	1 oz. bottle red ink	6883
	The above parts are for a Bristol thermometer controller Model 1T1X500B-2, serial number 767211.	
4	IC thermocouples, length 30"	3BS14N2
	The above thermocouples are for a Bristol pyrometer Model 487-L, serial number 202953	

THE BRISTOL COMPANY

MAIN OFFICE AND FACTORY • WATERBURY 20, CONNECTICUT

In Canada—Main Office and Factory
THE BRISTOL COMPANY OF CANADA LIMITED
71-79 Duchess Street, Toronto 2, Ontario—Phone: Empire 3-3423
Branch Office at Dominion Square Building, Montreal 2, Quebec
Phone: Lancaster 2517

In Great Britain—Main Office and Factory
BRISTOL'S INSTRUMENT CO. LTD.
Lynch Lane, Weymouth, Dorset, England

BRANCH OFFICES

AKRON, OHIO	Telephone	Enterprise 4146
ATLANTA 3, GEORGIA	231 Healey Building	Walnut 7607
BALTIMORE 2, MARYLAND	501 Mathieson Building	Saratoga 2427
BIRMINGHAM 3, ALABAMA	324 Comer Building	3-0034
BOSTON 16, MASSACHUSETTS	802 Statler Building	Hubbard 2-1728
BUFFALO 7, NEW YORK	1807 Elmwood Avenue	Delaware 3754
CHARLOTTE, NO. CAROLINA	P. O. Box 3180	4-0050
CHICAGO 11, ILLINOIS	351-363 E. Ohio Street	Whitehall 4-2190
CINCINNATI 23, OHIO	3730 Colerain Avenue	Kirby 0400
CLEVELAND 2, OHIO	8905 Lake Avenue	Atlantic 6924
DENVER 2, COLORADO	Hamilton Associates 612 Insurance Building	Cherry 1505
DETROIT 16, MICHIGAN	1627 W. Fort Street	Woodward 5-2992
HOUSTON 19, TEXAS	1705 West Gray Avenue	Linden 2881
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KANSAS CITY, MISSOURI	1001 Commerce Building	Harrison 5336
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MILWAUKEE 3, WISCONSIN	231 W. Wisconsin Avenue	Daly 8-4393
MINNEAPOLIS, MINN.	P. O. Box 1101	Atlantic 0714
NEW YORK 19, NEW YORK	250 West 57th Street	Circle 5-4953
PHILADELPHIA 7, PA.	Market St. Natl. Bank Bldg.	Rittenhouse 6-2386
PITTSBURGH 12, PA.	210 E. Parkway, N. S.	Fairfax 1-5190
ST. LOUIS 2, MISSOURI	433 Cotton Belt Building	Chestnut 7892
SALT LAKE CITY 1, UTAH	Specialty Sales Company 206 South West Temple	3-5553
SAN FRANCISCO 7, CALIFORNIA	40 Berry Street	Garfield 1-5462
SEATTLE 1, WASHINGTON	6624 White Building	Elliott 3361
TULSA 3, OKLAHOMA	1508 Thompson Bldg.	4-6468
WASHINGTON, D. C.	Telephone	Republic 0655
WATERBURY 20, CONN.	Bristol Road	3-5151

BRANCH FACTORIES

CHICAGO 11, ILL. 351-363 East Ohio Street

SAN FRANCISCO 7, CAL. 40 Berry Street

Printed in U.S.A.

A Recorder Is No Better Than Its Chart. For 40 years Bristol engineers have worked to better methods for producing recording instrument charts. Today, all charts are printed from masters prepared from engine engraved wax originals—a method developed by us. Cooperation with our paper suppliers has produced custom made chart papers with special inhibitors to retard moisture absorption, special sizing to give just right inking, lowest dimension changes due to humidity, and perfect flatness. Paper stocks are "cured" at constant humidity & temperature until absolute uniformity of dimensions is assured and then printed in an air conditioned shop. Printing and center hole punching are done simultaneously, achieving perfect concentricity. The result is charts yielding the highest accuracy of performance under a wide variety of conditions. Bristol prints over 600,000 pounds of charts yearly. Bristol instruments are guaranteed only when using Bristol's Charts.

Buy Charts in Quantities and Save. Discounts up to 50 and 40% are allowed on charts purchased in quantities.

Bristol's Annual Chart Requirement Plan. Enables large users to place orders for as few as 1,000 charts at a time, yet receive discounts based on their estimated total yearly purchases. Such orders may be assorted as to size and number, but must be for shipment to any single destination. (Strip and smoked charts excluded.)

Review the chart requirements of your entire organization and save by either above plan.

Bristol Recorder Ink Is Specially Compounded. Thirty years of laboratory development and field test have produced inks in 8 colors—non-fading even in atmospheres containing chlorine and sulphur dioxide fumes. Bristol Standard ink possesses the right surface tension for smooth flow and clean tracings, the right drying rate for average chart speeds, and is free of solids which plug pens. Bristol makes low temperature inks which will dry but not freeze at ambient temperatures down to —65°F and high temperature inks recommended for ambient temperatures up to 400°F. It is economical to buy Bristol's ink in pint, quart and gallon bottles to refill the handy 1 ounce dropper stoppered bottles supplied with each instrument.

Use Genuine Bristol Parts. Only Bristol replacement parts are identical with those originally built into your instrument. They assure ease of replacement and perfect performance.

● **THERMOCOUPLES** — Bristol tests thermoelectrically before shipment from our suppliers and after receipt at our factory every batch of thermocouple wire stock, accepting only those meeting precision checks against the National Bureau of Standards.

Buy Bristol's Thermocouples to obtain replacements which are exact duplicates of those for which your pyrometer was originally calibrated.

Service Chart Drives. Both main and branch factories carry stocks of carefully rebuilt, fully guaranteed chart drives, both spring and electric, which will be exchanged for your defective chart drive for a nominal charge. Note: in order to positively identify speed, gear ratios, mounting, etc., *we must receive your old chart drive before shipping the replacement.*

BRISTOL FIELD SERVICE

A coordinated, nation wide instrument engineering organization planned to serve users of industrial instruments whatever their problem — wherever they are located. Staffed by genuine experts in instrument application and maintenance.

Branch Factories. Three well equipped Branch Factories located across the nation in key industrial centers to speed up repair jobs and delivery of replacement parts and supplies. Each is manned by factory trained workers using factory methods, equipment and genuine Bristol parts in all phases of fabrication, calibration and repair. Instruments reconditioned in our factories carry the same guarantee as a new instrument. Parts and supplies likely to be needed in emergencies are stocked in all Branch Factories.

Sales Offices. Twelve Sales Offices located in strategic industrial cities thruout the United States and Canada, staffed by instrument engineers with years of "know how" in solving instrumentation problems of the industries peculiar to their districts. Call on these offices for personal engineering study, technical proposals and accurate quotations on your automatic process control problems.

Field Engineers. Over 50 experienced instrument engineers—experts in applying recorders and automatic controllers to industrial processes. These are the men who go into your plant, study your process and recommend equipment best suited to your job. They are available without cost or obligation to help you plan your instrument installations.

Service Engineers. Twelve field Service Engineers, all factory trained, to install, check, adjust and repair Bristol's instruments in the user's plant. Available at reasonable rates to go anywhere in the United States or Canada to maintain in your Bristol instruments, thru many years of usefulness, the same high accuracy and performance originally built into them. Bristol's Engineers make trips thru most parts of the United States, Canada, Cuba and England at frequent intervals. Avail yourself of this service by contacting the nearest Bristol Office.

Periodic Service Plan. A systematic plan designed to keep Bristol's instruments at top performance and accuracy. A Bristol Service Engineer calls periodically two to twelve times a year to inspect, check calibration, adjust, lubricate and repair all Bristol's instruments in the user's plant. We fix them *before* they fail! Use this plan to *prevent* costly lost production and product spoilage due to instrument break downs. Contact the nearest Bristol Office for full information on yearly contracts covering the Periodic Service Plan.

Technical Consulting Service. A complete consulting service based on over 60 years of experience in applying instruments to tens of thousands of widely varying processes and equipment. Just supply us with complete data—temperature and pressure ranges, flow rates, chemical characteristics, mechanical limitations, etc., and a sketch of the equipment. Our factory Application and Specialty Engineering Departments are available to advise automatic instrumentation for your tough and unusual processes.

BE SURE TO MENTION SERIAL AND MODEL NUMBERS WHEN ORDERING PARTS, INSTRUCTIONS AND DIAGRAMS

THE BRISTOL CO. WATERBURY 20, CONN.

BRISTOL'S

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